SCIENCE

FRIDAY, JUNE 30, 1916

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THE ALCOHOL PROGRAM OF THE NUTRITION LABORATORY WITH SPECIAL REFERENCE TO PSYCHOLOGICAL EFFECTS OF MODERATE DOSES OF ALCOHOL ON MAN[1]

ALCOHOL in not too large doses, taken by the mouth, is undoubtedly burned in the body and in this burning gives off heat which replaces equivalent energy ordinarily derived from food or body substance. This has been absolutely demonstrated by Professor Atwater and his associates with the respiration calorimeter at Wesleyan University, Middletown, Conn. This scientific proof of the important rôle that moderate doses of alcohol may play in the human energy economy finds verification in the masterly, statistical studies of Armand Gautier in Paris, who has shown that there are certainly several million people who regularly receive in their daily diet somewhat more energy in the form of alcohol than they do in the form of protein. What has been demonstrated of the French is probably true of many others. Thus we see that a physiological study of alcohol is, on abstract, scientific grounds, essential to a complete understanding of the materials regularly ingested which serve as the sources of energy to the body.

Although protein, fat and carbohydrates have long been studied in a systematic manner, alcohol in recent years has, in spite of the agitation regarding its moral, economical and sociological importance, received but scant, irregular attention in a relatively few scientific laboratories. With regard to its physiological action there

[1] An address given before the New York Academy of Medicine on April 6, 1916.

exists much speculation and a minimum of verified facts. This condition should be reversed, and a great deal of hypothesis which, for the most part, lies outside the realm of probability, should be replaced with a careful series of attested facts obtained under conditions insuring the best available technique, with a sufficient number of subjects and a multiplicity of observations accompanied by controls and normals. Such a procedure is outlined in the program prepared by the Nutrition Laboratory and submitted for criticism to over 400 physiologists, clinicians and psychologists a year or two ago. It is my purpose this evening to bring to your attention this program, its scope, its intentions, and more specifically to present to you in brief abstract the results of our first work on the psychological phase of the alcohol problem.

As the outcome of two extended foreign tours, when the general subject of physiological and psychological research on alcohol was discussed with many scientists, it became evident that:

1. Alcohol investigations are, as a rule, undertaken with diffidence, owing to the fact that relatively few investigators can afford the time or funds necessary to make the observations sufficiently numerous and extended to meet the stringent requirement of critics who, while frequently unscientific, are invariably captious.

2. Objectivity in writing on the subject of alcohol is as rare as uncontaminated scientific evidence.

3. Interpretations of the results of alcohol investigations made outside of the source of experimental evidence have been usually so confused by preconceived ideas of the reader as to lead to the most divergent interpretations of one and the same collection of data. In general an interpretation has been the resultant of scientific record plus the personal, ethical opinions of the reader, with the last named factor usually playing the controlling rôle.

Perhaps these discouragements to vitally needed abstract research on alcohol are after all blessings in disguise; to meet the demands of these adverse conditions tests the mettle of both the experimenter and the writer.

The rapid advances in physiological research, especially in the study of the energy factors both by direct and by indirect calorimetry, the availability of physiological instruments of precision, such as the string galvanometer, sphygmomanometer, electrical resistance recording thermometer, and appliances for the study of muscular work on an accurate basis, and an adequate technique for certain psycho-physiological observations made it seem feasible for the Nutrition Laboratory to begin a study of this general question, with the idea of using its resources and staff in such a manner as to convince all but the most captious of critics of the reliability of the data if not, indeed, of the legitimacy of the interpretation of results. To this end, and especially to secure a working outline which will correlate the immediate and later researches of all laboratories, a somewhat detailed program was planned.

In this program for experimental researches on alcohol the effect of only moderate doses is considered, since the effect of excessive doses with final complete narcosis is obvious. The importance of such a study of the influence of moderate amounts of alcohol is brought out in the introduction of the program.

Furthermore, emphasis was laid upon those points which in previous alcohol investigations had been most severely attacked. Thus, particular attention was given to the size of the dose, the character of the subject experimented upon, the question of repeated versus single doses, the

method of administration, *i. e.*, by mouth and by rectal enema, the time relations between the ingestion of alcohol and of varying foods as well as during fatigue, and the importance of securing adequate controls or base line measurements. This last point was especially emphasized, for in an alcohol investigation controls play as important a rôle as do the alcohol experiments.

A considerable part of the program is given to the general field of physiology, especially those factors which previous experience has shown might react more markedly to alcohol dosage. Studies of the respiration, digestion and secretion, metabolism, and the heat regulation are provided for. Finally, it was believed that since in studies of the metabolism the subjects would normally be under more or less control as to diet and alcohol ingestion, such investigations would provide an excellent opportunity for making simultaneous observations of the psychological effects of alcohol. A section of the program was therefore devoted to a plan for this research. The psychological part of the program was prepared by Dr. Dodge.

It is thus seen that the investigation to be carried out by the Nutrition Laboratory is based upon a carefully prepared program which has been submitted for criticism to a large number of individuals. That it will undergo material modification in the course of time is naturally to be expected, but with this program all completed researches may be correlated and profitable lines suggested for immediate attack.

The material resources of the Nutrition Laboratory of the Carnegie Institution of Washington, located in Boston, made it possible to commence upon this program immediately. The equipment of the laboratory includes several forms of respiration chambers and respiration calorimeters, the latter being placed in a room specially designed for studying heat measurements. Of the calorimeters the one most used is the bed calorimeter which was employed in the prolonged fasting experiment recently reported.[2] It is with these calorimeters that we expect to study many of the problems suggested in the tentative program. A portable form of respiration apparatus has also been developed and extensively employed in studies of the basal metabolism and in other researches in which the gaseous exchange is of special interest. At times no less than four such pieces of apparatus have been used simultaneously in the large respiration calorimeter room.

Without detailing further the equipment of the laboratory which may be used in the general study of the alcohol problem, we may immediately turn our attention to a specific discussion of the psychological section of the alcohol program. As Dr. Dodge was able to concentrate his entire time for a year upon this part of the work at the Nutrition Laboratory, sufficient data have already been accumulated to justify the publication of a monograph[3] on this phase of the subject. This work was carried out at the Nutrition Laboratory chiefly by Dr. Dodge and I should at this point state that when I say "we," I should more properly say "Dr. Dodge."

A special laboratory was prepared for the purpose with darkened walls to facilitate photographic technique and fitted up with psychological apparatus. The chief items of equipment consist of a string galvanometer and accessory apparatus, the electrically-driven Blix-Sandström kymograph, which is of general use, a complete equipment for the determination of the threshold for faradic stimulation (Martin

[2] Benedict, Carnegie Institution of Washington Publication No. 203, 1915.

[3] Dodge and Benedict, Carnegie Institution of Washington Publication No. 232, 1915.

method), and photographic apparatus with suitable luminants for registration of the protective wink reflex and of the eye movements. Both of the special cameras here used were designed by Dr. Dodge. Many other most ingenious devices for studying the problems arising in the course of the development of the psychological program were made by the experimental skill of Dr. Dodge and will be referred to later.

DESCRIPTION OF TESTS

Three fundamental principles determined our selection of the group of experimental measurements:

First, the attempt to secure a group of systematically coordinated measurements.

Second, the principle of relative simplicity, that is, we attempted to investigate elementary neuro-muscular processes in their simplest available form, and of the more complex processes to choose those involving as few unknown factors as possible. In particular we tried to measure processes that were insusceptible to direct and arbitrary conscious modification and as free as possible from uncontrollable influences of bias, effort and attention.

Third, and finally, we attempted to select those processes in which the motor response of the subject would be a thoroughly natural and familiar act, that is, a customary reaction.

The effect of alcohol on a relatively simple neural arc, the patellar reflex, has especial significance to clinicians who have long used it for diagnostic purposes. To render its study most capable of accurate scientific interpretation special apparatus was employed for giving the stimulus, and the latency of the response and degree of contraction of the quadriceps muscle was graphically recorded. The stimulus was given by two pendulum hammers of the same weight so placed as to strike the tendon. By means of a system of light levers fastening directly over the quadriceps muscle, the muscle thickening could be directly recorded on the kymograph and the shock of the impulse blow of the hammer made it also possible to record the moment of stimulus. From the moment of stimulus to the beginning of the rise of the curve, the height could be directly read and the extent of the quadriceps thickening could be obtained by noting the height of the curve and applying a simple factor.

Another simple neural arc which lends itself admirably for study is the protective lid reflex. By projecting a beam of light across the eyelid so that the shadow of an eyelash will fall upon a sensitive plate moving horizontally in a camera, a complete photographic registration showing the moment of stimulus, together with a picture of the lid movement, was obtained. The stimulus was produced by a sounding board struck by two spring hammers, the whole stimulus system having a small pointer whose shadow likewise fell over the camera slit, and thus was simultaneously photographed. As the moving plate was set in motion the stimulus hammers were electrically released and the moment of stimulus and the beginning of lid movement, as well as the height of response, were photographically recorded. It is extraordinarily difficult for a subject to alter the nature of the protective lid reflex or of the knee jerk without this alteration being evident in the records, and we have here, we believe, two indices that give us as nearly uncontaminated data as one could at the present time expect.

Of the complex neural arcs the movement of the eye to a peripheral visual stimulus is one of the common experiences of everyday life. Consequently, by means of the Dodge photographic registration of the movements of the eye, it was possible to record photographically the time required

for the eye to react, *i. e.*, to look over to a new stimulus to the right or to the left of the position which the eye has been occupying. The subject was placed with his eye near the lens of a long photographic camera; a beam of soft blue light from an arc lamp was then projected at will upon the eyeball and reflected through the lens, which focused it to a small point upon a sensitive plate in the camera. The eye looked at a fixation mark; this suddenly disappeared, exposing in an unknown position a single letter which was 1, 2 or 3 centimeters to the right or to the left of the fixation mark. At the moment of exposure the actinic light was allowed to fall upon the eyeball. A tuning fork interrupted the light so that the record consists of a line of dots, each dot representing one hundredth of a second. A bend in the line indicates the moment of reaction, thus giving a photographic record of the latent time as well as the direction of movement.

A second complex neural arc was the reaction time to reading isolated words. With an exposure apparatus of unique advantages 4-letter words were exposed, and the subject was instructed to pronounce each word immediately as soon as he saw it. By means of a voice key with electric contact a record could be made on the kymograph drum of the moment of exposure of the word and the instant of response, thus giving the data for determining the latency of response.

In conjunction with Dr. F. L. Wells, of the McLean Hospital, a series of standard free association tests were given to the subjects. The procedure is so well known as to make a description unnecessary here.

Considerable attention was paid to the effect of alcohol on memorizing, this being one of the higher mental processes. A series of 4-letter words were exposed backwards by attaching to the kymograph drum a piece of paper on which these words were printed. As the drum rotated the last letter of the word appeared first in the window which limited the subject's view, and not until the last letter had in turn appeared could the subject pronounce the word correctly. The words were repeated three times and the saving in time required to repeat the words in order was taken as an index of residual memory. Occasionally subjects could memorize the entire twelve words so as to have a perfect score, pronouncing each word before it was exposed.

The effect of alcohol on the sensory threshold was studied by means of the faradic stimulation method of Martin. This requires a carefully calibrated Kronecker inductorium; the technique has been admirably described by Dr. Martin.[4] Very feeble shocks were produced and the subject, with two fingers dipped in salt solution, was told to indicate when the shock was felt. By moving the coil in and out a threshold could be established. Variations in the position of the coil were the basis of a series of calculations which Dr. Martin has developed, giving the results in the terms of certain units. Since our work is entirely differential, however, it is unnecessary to discuss the character of these units.

No series of observations on the psychological effects of alcohol would be complete without studies of the effect of alcohol on motor coordination. After a considerable amount of preliminary experimentation we decided upon two measurements, the first on the velocity of eye-movements, *i. e.*, in moving the eye from side to side through an arc of about 40°, the second on the reciprocal innervation of the middle finger. The importance of the eye as a member for studying muscular coordination has been

[4] Martin, "The Measurement of Induction Shocks," New York, N. Y., 1912.

emphasized by Sherrington and has been given special attention by Dodge. It is relatively impossible to control voluntarily the rate of moving the eye from one point to another, as this invariably results in an intermittent motion. By having two fixation marks and, on signal, moving the eye as rapidly as possible from one to the other, a photographic record was made of the eye movements. The time is recorded directly on the plate as in eye reaction records, by means of the light interrupter. From this record we count up directly the number of hundredths of a second required for the eye to move through this arc of 40°. This time or velocity measurement is the basis of our discussion. Of course the record indicates the accuracy with which the eye looks at these two marks and also the number of times that the eye moves from mark to mark. This technique has proved most satisfactory.

Since eye movements are not well adapted to show the rapidity of free oscillation, as successive eye movements are separated by moments of fixation, we adopted the reciprocal innervation of the middle finger for measuring the speed of alternating reciprocal innervation of antagonistic muscles. The finger movements were recorded in the following manner:

A very light lever, the weight of which was not borne by the finger, but held by a pivot, was attached to the middle finger of the right hand and the projection of the lever placed opposite the slit of a photographic camera, so that the shadow of the lever could be photographed directly. At the same time electrocardiograms were taken from body leads, thus giving the pulse rate; a respiratory curve and the time in seconds were simultaneously photographed. The number of finger movements during the first, second and third 2-second periods were the basis for discussion. Even in this short time distinct evidence of fatigue was noted.

With these important measurements of simple and complex processes, memory, electrical threshold, eye movements, and finger movements, a large number of pulse measurements were taken throughout the series of observations. After making tests with various forms of apparatus, we finally relied entirely upon electrocardiograms taken from body leads, two electrodes being attached to the chest, thus leaving the subject entirely free and untrammeled for any other simultaneous tests. The electrocardiograms were obviously not taken for diagnostic purposes and have value here as showing only the pulse rate. As the measurements were made not only during the mental work, but during moderate amounts of physical exercise, such as finger movements, rising, and two genuflections, the data obtained permitted us to draw conclusions regarding the heart rate during moderate mental and physical work.

In considering all of our experiments it is important to note that the processes selected for measurement are, we believe, for the most part remote from voluntary or conscious modification or control. The program was quite varied, the subjects passing from one series of tests to another, yet the apparatus was so disposed in the laboratory as to necessitate a minimum amount of extraneous muscular movement in changing from one position to another. Special care was taken to have the whole atmosphere of the laboratory quiet and serene.

SUBJECTS

The problem of collecting subjects for a research of this kind was by no means simple. It was finally decided that a good degree of intelligence was necessary for proper cooperation between subject and experimenter; furthermore, the moral respon-

sibility of giving irresponsible individuals even the distasteful mixtures of alcohol and water was not lightly to be regarded. We therefore decided that only those individuals who were of legal age, and who were college graduates, would be used. Consequently we had approximately ten such subjects and, through the kindness of Dr. E. E. Southard, these were supplemented by a group of three men from the Psychopathic Hospital in Boston to give some indication of the influence of previous excessive use. Our final deductions were drawn from an elaborate series of figures based upon approximately 7 normal and 3 psychopathic subjects, but by far the more extensive series of tests was carried out with the normal individuals.

METHOD OF COMPUTATION

At the outset it was emphasized that an extended series of normal or control experiments was absolutely essential. In fact, we made approximately as many control experiments as we did alcohol tests. This is believed to be good practise as the question of interest, fatigue and the invariably occurring but unforeseen rhythmic and arrhythmic changes throughout any given experimental day must be counterbalanced by control experiments of an extensive nature. Consequently the general method of experimentation was somewhat as follows:

First, the subject was given an entire normal day (about 3 hours) without alcohol. Later this session was duplicated, with a 30 c.c. dose of alcohol. At a third session the dose was raised to 45 c.c. and finally the series was concluded by another control day. In addition to the control tests at the beginning and end of the series, the first period of each alcohol day was given without alcohol, so that we have a "normal of the day," that is, the entire group of measurements for that given day was carried out once before alcohol was given and then subsequently alcohol was administered. The series of observations was repeated several times, depending upon the length of session; usually there were three and sometimes as many as six repetitions on a single day. To allow for the normal daily change, which was invariably noted in all repetition of sessions, we deducted from the "normal of the day" the values found in subsequent series of that particular day; these differences were the basis of our computation. A comparison was then made of differences for the two alcohol days with those for the two normal days; the effect of alcohol was represented by the difference found between the alcohol and the normal days. The statistical treatment of the subject gave us no little trouble; obviously the data permit of any other adjustment or rearrangement that statisticians may deem advisable.

RESULTS OF COMPUTATIONS

Considering only the effect of alcohol with the normal subjects, that is, the difference between the differences found on the alcohol days and those found on the normal days, we note that the latent time of the patellar reflex was lengthened on the average about 10 per cent. In other words, after the stimulus the response in the contraction was delayed approximately 10 per cent. The extent of muscle thickening was enormously reduced, this reduction being, on the average, 46 per cent. In fact this diminution in the muscle thickening was so great as to make it impracticable to conduct the experiment with most subjects after giving the 45 c.c. dose.

The second reflex studied, namely, the protective lid reflex, showed that the latent time was increased 7 per cent., while the extent of lid movement was decreased 19 per cent., a picture perfectly comparable with that of the patellar reflex.

The latent time of the eye reaction, that is, the time elapsing between the disappearance of the fixation point to the movement of the eye appropriate to the stimulus, was increased 5 per cent. In other words, the reaction was distinctly delayed.

In the speech reaction tests, in which the subject was asked to pronounce a word shown in the exposure apparatus, the latent time was increased 3 per cent.

Memory and the free association were only slightly affected. The sensitivity to faradic stimulation was decreased 14 per cent. after alcohol, that is, the threshold was raised, a stronger shock being required to stimulate. In the motor coordinations the number of finger movements in 6 seconds decreased 9 per cent. with alcohol, and the velocity of the eye movement through an arc of 40° decreased 11 per cent., *i. e.*, there was a decrease in velocity both of finger movement and of eye-movement. Thus we see that all the tests thus far show a distinct depressive action of alcohol, a minimum effect being observed in the more highly organized processes, such as memory and the free association.

The large number of pulse observations made during mental work and during moderate physical work showed invariably a relative acceleration of the pulse; this is in striking contrast to the general depression of the neuro-muscular processes at all levels of the cerebro-spinal system. To make this clear, it should be stated that during the sessions of a normal day the pulse rate would tend to decrease with fair regularity from hour to hour. For example, the average pulse rate for the first half hour might be 80 per minute and the rate might decrease until the average for the last half hour would be 62 per minute. On the normal days this picture is very clear. On the alcohol days this decrease is not nearly so large as on normal days. In no instance is the pulse rate higher at the end of the day than at the beginning, but the normal drop does not occur. In other words, we have here distinct evidence of a relative acceleration. Under all conditions of moderate mental and physical work the pulse rate after alcohol did not fall to so low a level as it would have fallen without alcohol.

Summarizing the effect of alcohol we find, then, that the two reflexes showed a distinct lengthening in the latent time of 10 per cent. for the patellar reflex and 7 per cent. for the lid reflex, a decrease in the muscle thickening for the patellar reflex of 46 per cent. and in the extent of the lid movement of 19 per cent.; the sensory threshold was raised 14 per cent.; the two motor coordinations showed a decreased action under alcohol of approximately 10 per cent.; the two elaborated reaction times of the eye and speech organs showed changes of 5 and 3 per cent. respectively, and the memory and free association were unaffected. The natural grouping of these processes is too consistent to be accidental. It is confirmatory evidence of the reliability of our results that similar processes gave similar results. Furthermore in the cases in which there are comparable data it is shown that in 5 out of 6 processes the greater average effect was the result of the larger dose.

It is surprising that the higher processes were apparently not so much affected as the reflexes, but it is significant that the greatest, most persistent change incidental to the ingestion of alcohol is in those processes which are most distinctly exempt from voluntary reinforcement or voluntary control. The higher senses alone show capacity for autogenic reinforcement. This we noted several times in the progress of our experimenting. One most striking illustration was when one of the subjects, during the association test, went to sleep for a

few seconds, and failed to hear one stimulus word; ten seconds later, after being awakened, he responded normally both as to latent time and the character of the associated word. There was a distinct effort in all cases for the subject to attempt to pull himself together to make a showing, but it is a striking fact that in spite of the autogenic reinforcement, with one exception the performance after alcohol was below normal. The one exception was the eye reaction to visual, peripheral stimuli after the 30 c.c. dose, where there apparently seemed to be facilitation as the result of the moderate dose of alcohol. An examination of the data for all the subjects shows, however, that there was a marked practise effect, which was entirely unlooked for in the arrangement of our experiments. But even this could not offset the effect of the larger dose, which invariably showed depression of the reaction.

In the analysis of our data it becomes necessary to consider all sensory and motor processes as the resultant of complex, stimulating and inhibiting factors. It was distinctly noted in our experiments that when there were definite inhibitory processes, such as, for example, in one or two instances where the protective wink reflex was inhibited as the result of training, that this inhibition suffered first under alcohol. This was also noticeable in the threshold for faradic stimulation where alcohol disturbed the subject's caution and produced more numerous false reactions, that is, reactions when there were no stimuli. We have, on the one hand, with the higher senses a capacity for autogenic reinforcement, and, on the other hand, a tendency for the alcohol to affect inhibition. It seems not unlikely that we have here a partial explanation at least for the wide variety of effects which are commonly observed in the social use of alcohol, where environment gives the reinforcement and alcohol reduces the inhibitions. Our evidence is positive, however, that the ingestion of alcohol results in a depression of neuro-muscular processes and that these phenomena can not be reduced to the excitation of the inhibitory processes. But conversely, whenever an apparent excitation occurs as a result of alcohol it is either demonstrably (as in the case of the pulse rate, the reflexes, memory and the threshold) or probably (as in the eye reaction) due to a relatively overbalancing depression of the controlling and inhibitory processes.

The most apparent exception to the general trend of depressions noted in all the processes was that of the pulse. A careful analysis of individual pulse cycles showed, however, by the method of Reid Hunt, that there are large variations in the length of diastole after alcohol. Since many of our experimental observations were made in relatively short periods, it appeared logical to assume that the changes in pulse rate were due not to the stimulation of the slow-acting accelerating mechanism, but to the rapidly reacting inhibitory mechanism. We may therefore explain this apparent relative acceleration of the pulse rate on the ground of a partial paralysis of the cardio-inhibitory mechanism.

It is also of interest to note the time of the maximum effect of alcohol in the various processes. In general there was a remarkable uniformity in the time after the ingestion of alcohol when the greatest effect was noted. This was practically from 90 to 100 minutes, in other words a little over an hour and a half, and essentially constant for all the processes.

Finally, to note if there was a central tendency in any one of the particular series of measurements we compared the average effect of alcohol upon each process for the individual subjects with the average for the

group and found that the average effect was closely approximated by the effect upon the motor coordinations, *i. e.*, finger movement and eye movement. Aside from the practical value of this correspondence between the effects of alcohol on the coordination processes and the average effects, it has a rather far-reaching, theoretical implication. If, in all the diverse processes that we have measured, the coordination processes represent a central numerical tendency, it must be that they correspond in some closer way than the rest to the real central tendency of the alcohol effect. It would seem to indicate that the change in the average performance of our subjects due to alcohol was a function of central coordination. If this indication is substantiated by later investigations it should prove to be not only of the utmost importance for the understanding of the various manifestations of the effects of alcohol in individual cases and of the general phenomena that accompany its excessive use, but it would throw a flood of light on the complex organization of normal psychophysical processes as well as on the effects of fatigue and other depressing agents.

In reporting these results I feel that the techniques outlined above have been adequate to this type of problem, that the controls have been satisfactory, and that the data and interpretations have been presented with the least amount of personal bias that is possible to scientific investigators. But naturally these results must not be considered as having settled the alcohol problem as regards the psychological effects of small doses. As all present know, the literature in this field is very large and there are numerous contradictions in results and interpretations. It is very rarely possible for one investigator to duplicate the apparatus, methods and general conditions of another. This is doubtless one of the main causes for confliction. We therefore feel that one of the important contributions to our program and scheme of work on the alcohol program should be the continued massing of data over a period of years. It is also advisable that the data should not be collected by one experimenter. If two experimenters, both carefully trained, and thoroughly familiar with the same group of methods should use these methods on a different set of subjects, but under similar laboratory conditions, comparisons of these two sets of results should be of great importance. If they are opposed to each other, it is a good index of unknown or uncontrolled factors in the problem, insufficient data, carelessness of technique, or wrong statistical treatment. On the other hand, should these results confirm each other in the main, and especially if both groups of data are fairly large, this confirmation should place these results upon a plane which is unique in the annals of alcohol experimentation.

It will doubtless be considered of enormous practical significance that in none of our data have we any indication of the pure facilitation effect of alcohol. Contrary to the theory of Kraepelin, we not only found no facilitation of the motor processes, but the depression of the simplest forms in the finger and eye-movements seems to be one of the most characteristic effects of alcohol. Certain it is that, in conjunction with the pulse acceleration, the general neuro-muscular depression may be regarded as presumptive evidence of the effect of alcohol on organic efficiency. It is, however, of vital importance in seeking to transfer the results of such laboratory demonstrations as have been here reported to a general consideration of alcohol on industrial efficiency to recall that the higher central processes by reason, we believe, of autogenic reinforcement showed the least effect. Indus-

trial processes are by no means solely confined to motor coordination, and I must emphasize that the data of this report may not be uncritically applied to industrial situations. More complex processes, such as typewriting, which seem to apply more directly to industrial environment, are being studied, and their various factors analyzed by my colleague, Dr. Walter R. Miles, experimental psychologist of the Nutrition Laboratory. It is only upon the basis of such analysis that justifiable conclusions may be made with regard to the effect of alcohol upon the mental and physical demands of industrial environment.

It may be added that the material already published is being further elaborated, both experimentally and statistically, by Dr. Miles.

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CINCHONA AS A TROPICAL STATION FOR AMERICAN BOTANISTS

IT is now practically assured that some fourteen American universities, botanical foundations and individual botanists are to cooperate with the Jamaican government in the support of Cinchona as a tropical station. A move to aid in the support of Cinchona, initiated by the Botanical Society of America in 1912, was not consummated, in consequence of the earlier leasing of the station to the British Association for the Advancement of Science. The Jamaican authorities and the British Association seem quite willing, under present conditions, to allow the lease to pass into American hands after October next.

The attention of American investigators should, therefore, be directed to the facilities for botanical research offered by this oldest and best known botanical laboratory in the western tropics.

A brief description of the location of Cinchona and of its botanical environment has recently appeared in *The Popular Science Monthly* (December, 1914, January, 1915). Among the advantages of this station for American botanists there enumerated are the greatly varied flora and series of types of vegetation; the proximity of a library and of two other botanical gardens, beside that surrounding the laboratory. The location of Cinchona is a very fortunate one for American botanists from a practical standpoint. It is in an English-speaking country with good roads, a stable government and adequate quarantine service. It is also within easy reach of our eastern seaports, from several of which the round trip to Jamaica and Cinchona can be made in summer for $75.00 or less for transportation.

In order to give a more adequate idea of the advantages of Cinchona for several different types of research I have asked four investigators who have worked there to suggest the opportunities presented at Cinchona for research in the four or five lines which they have followed. These outlines are appended under the names of their respective authors.

It is altogether probable that any American botanist wishing to work at Cinchona during the coming summer will be granted the privilege by requesting it of the colonial government of Jamaica through Superintendent William Harris, F.L.S., Hope Gardens, Kingston, Jamaica. The writer and the authors of the appended notes on the botanical opportunities of Cinchona will be glad to give any information, within their knowledge, of conditions at and about the laboratory.

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BALTIMORE,
May 25, 1916

THE FERN-FLORA OF CINCHONA

THE writer has visited a good many regions rich in ferns, but none equals Jamaica either in number of species or individuals. The extraordinarily varied conditions in Jamaica, due largely to its topography, result in a variety of the fern flora which is really amazing. About five hundred species are reported from this small island, of some four thousand square

miles in extent—a number much exceeding that of the whole of North America north of Mexico.

The high rain forest of the Blue Mountains in the neighborhood of Cinchona, is especially rich in Pteridophytes and Hepaticæ, and offers very exceptional opportunities for collecting material of a great variety of interesting ferns, especially many types which are quite unrepresented in the United States, or at best are represented by a very few extremely rare species.

The very important order, Marattiales, entirely absent from the United States, is represented by species of *Marattia* and *Danæa*, abundant and easily collected. The beautiful filmy ferns, Hymenophyllaceæ, abound and comprise numerous species of *Hymenophyllum* and *Trichomanes*.

Tree ferns of the genera *Hemitelia, Cyathea* and *Alsophila* are very abundant, sometimes 30–40 feet in height, and the Polypodiaceæ are represented by an enormous number of species. The Gleicheniaceæ and Schizæaceæ are better developed at lower elevations, but may be procured without much trouble.

Numerous species of *Lycopodium* and *Selaginella* are common, and at lower elevations in the Blue Mountains one sometimes finds thickets of *Equisetum giganteum*, ten or fifteen feet high.

In the neighborhood of Cinchona—and indeed all over the island—the Hepaticæ are very abundant, and include many rare and interesting forms, which can not be given here in detail.

Douglas Houghton Campbell
Leland Stanford Jr. University

Lichens and Bryophytes at Cinchona

The region around Cinchona is remarkably rich in Bryophytes and Lichens. Even in the immediate vicinity of the station excellent collecting grounds are available, such as the trees behind the laboratories, the trail to and through Morce's Gap, and the trail to Newhaven Gap. More distant points, such as John Crow Peak, Sir John Peak, Mabess River and Doll Wood, yielded additional species in great variety and can be visited without difficulty.

From the standpoint of the Hepaticæ, to which the writer devoted particular attention during his two visits to Jamaica, the epiphyllous species and the distinctly tropical genera are perhaps the most striking and interesting. Most of the epiphyllous forms belong to the Lejeuneæ and include the genera *Odontolejeunea* and *Leptolejeunea*, together with species of other genera. In addition to the Lejeuneæ the tropical genera *Symphyogyna, Tylimanthus, Syzgiella, Isotachis* and *Dendroceros* are well represented, and many genera known in northern regions by a single species or by a small number of species here attain a remarkable luxuriance. This is strikingly true of *Plagiochila, Lepidozia, Bazzania, Frullania* and *Anthoceros*. Other northern genera, such as *Gymnomitrium, Marsupella, Jungermannia* and *Lophozia*, are either absent altogether or very sparingly represented.

The student of taxonomic problems soon becomes impressed by the imperfection of our knowledge of tropical species and by the difficulties of interpreting the older records regarding them. It will, in fact, be a very long time, unless the number of workers becomes much greater, before our knowledge can even approach completeness. The study of tropical Bryophytes involves careful work in the field followed by careful study in the laboratory and herbarium, and the facilities offered at Cinchona and Hope Gardens are probably unequalled anywhere else in the tropics except at the botanical garden of Buitenzorg.

A. W. Evans
Yale University

Cytological Material at Cinchona

The region about Cinchona offers many advantages to one desiring material for cytological study. The flora is so varied and profuse that the student of almost any group of plants will there find valuable material. This is notably true of lichens, liverworts, ferns and flowering plants. Much light is frequently thrown on perplexing cytological problems by the study of related genera and species; and

thus to one whose investigations have been confined to those species growing in the temperate zones, Cinchona furnishes splendid opportunity for the extension of his work to such allied tropical species.

A tropical rain-forest presents peculiar conditions. The plants do not show the marked periodicity characteristic of colder and dryer regions. Where the temperature and rainfall are so nearly constant at all times of the year as at Cinchona, one is likely to find all of the stages in the life history of a species on almost any single day, and conditions are favorable for collecting the year around. In the plants of a tropical rain-forest, moreover, there is much less cutin, fewer hairs, etc., to interfere with the penetration of fixing solutions, and hence there is the probability of better fixation. That such is not in all cases true is evidenced through the impermeability of the walls of fern sporangia, and the hairiness of the leaves of the Gymnogrammeæ may be as striking here as elsewhere.

To the cytological collector a compound microscope is an absolute necessity; and such a permanent station as that at Cinchona, therefore, seems to be the only solution to the accessibility of such regions. The buildings at Cinchona, including two cottages, a two-room laboratory, the drying house, the dark room, the greenhouses and the garden, were all in good condition when I left there in December last. Through the kind offices of Mr. William Harris at Hope Gardens servants were made available, and one's personal needs adequately supplied. The space is sufficient for a number of investigators at one time, and life there is very pleasant indeed.

C. H. FARR
COLUMBIA UNIVERSITY

EXPERIMENTAL WORK AT CINCHONA

THE portions of the Blue Mountains which are accessible from Cinchona, at both higher and lower altitudes, exhibit a diversity of vegetation in correlation with the widely differing temperature and moisture conditions, and also a vertical diversity from floor to canopy within the rain-forest itself. Ample opportunity is thus offered for the investigation of the physical environment in relation to the local and general distribution of plants. A wide range of plant material is available for the study of general physiological behavior as well as for the special types of activity characteristic of rain-forest plants. The fundamental processes of plants, as carried on under extremely humid conditions, and the influence of the character and rate of these processes upon the growth, distribution and periodic phenomena of the hygrophytic vegetation offer a rich field for future work at Cinchona. The gardens, greenhouses and various outbuildings afford opportunity for propagating plants and for placing them under a variety of experimental conditions. The nearness of an extensive tract of virgin forest is also a valuable asset for physiological as well as ecological work. The excellent trails, the easy means of communication and supply, the presence of a guide with a knowledge of the local flora, and the very healthful living conditions combine to make Cinchona an extremely useful station for those who may wish to carry on more or less prolonged investigations in the problems of the semi-torrid and humid tropics.

FORREST SHREVE
THE DESERT LABORATORY

UNIVERSITY AND INDUSTRY[1]

1. THIS Committee was appointed at the April, 1916, meeting to consider the papers presented at the meetings in November and December, 1915, and in April, 1916, and to report at the June, 1916, meeting; this report to embody the findings, conclusions and recommendations of this committee based upon the foregoing material, supplemented by such other as this committee was able to consider.

2. Your committee was divided into three subcommittees to examine the above subject-matter from three different points of view: Firstly, that of the university; secondly, that of the industries, and thirdly, that of the consulting chemists. Each of these subcommittees reached its conclusions separately and these conclusions were then submitted in writing to the full committee. The work of the whole committee is given in the following under

[1] Report of a committee of the New York Section, American Chemical Society.

three headings, namely: Findings, Conclusions and Recommendations.

FINDINGS

(*a*) Research is the source of all added knowledge.

(*b*) The universities are properly institutions of research.

(*c*) The proper development of university research requires unlimited and unrestricted publicity as to all its activities and results.

(*d*) Not all research activities of the industries can be published and it is only in such cases where publicity is compatible with industrial progress, that full cooperation between the universities and the industries can be effected.

(*e*) When a faculty-member as an individual works in conjunction with an individual industry and the results of that work are kept secret, that is not that cooperation between universities and industries which this committee is considering.

(*f*) Industrial or similar fellowships when founded by industrials or groups of industrials, coupled with publicity of the results, are effective modes of cooperation; the effectiveness of these fellowships diminishes as the number of contributing industrials decreases and the liberty to publish is restricted.

(*g*) In the case of problems of the industries where the results shall be held exclusive or secret or subject to patent, no general solution can be offered, but in each such case the individual industrial and the individual faculty-member or the individual institution must work out the best plan under the given set of conditions.

(*h*) No matter how efficiently the university may train its men, the industries that take up such men must be prepared to expend considerable of their own time, effort and money in training such men for the specific work before them.

(*i*) The tuition and fees paid by students cover only a small part of the cost of their education at the universities.

(*j*) Apprenticeship of chemists during summer vacations in the industries is not in general feasible, and in general is limited to routine experience in the analytical laboratory and not in the manufacturing plant proper.

(*k*) Scientific problems and the scientific side of technical problems are proper subjects for university treatment and investigation; the bringing of the university professor into the industries by having him examine the problem in the plant and determine the scientific aspect of the problem, and the pursuit of that problem in the university, is a promising point of entry for increased cooperation.

CONCLUSIONS

I. Cooperation, such as has been had heretofore, between associations of industries and institutions of learning for the solution of scientific problems or the scientific side of industrial problems, which are common to such specific industries, and the appropriate publication of the results of such investigations, has been productive of great public good, and the greatest immediate prospect for expansion of cooperation between universities and industries lies in coordinated effort along the above lines.

II. There are industrial problems not common to any group or number of plants and which can not properly be published, and these are, therefore, not adapted to university treatment; problems of this kind in the course of time do become common to the entire industries; to increase cooperation in this class of problems it is needful to accelerate the transfer of problems of this class to problems of the preceding class.

III. In order that there may be as little duplication of effort and labor as possible, and the greatest acceleration of cooperation, a permanent central committee should be created and appointed by representatives of the universities and the industries, and such committee should study opportunities and make public recommendations for cooperation along the lines laid down in these conclusions.

IV. Cooperation between universities and industries as to uniform requirements in the fundamentals of instruction seems possible, feasible and mutually profitable.

V. Such universities as aim to produce technical men should equip them with a working acquaintance with the fundamental types of machinery likely to be used in actual practise.

VI. In order to increase opportunity for research on the part of qualified faculty-members, relief from routine and administrative work within the university should be encouraged and executed to its reasonable limit.

VII. Our universities have a training capacity for branches of industry not now existent in this country; such unexploited training opportunities should be published by the universities to the end that our industrials and others might take up the advisability of creating such non-existent industry.

VIII. The industries can stimulate research by publishing such specific problems as may be common to the industry and yet not of sufficient importance to the industry to undertake their solution directly; such problems would afford valuable training for students and give them live material upon which to work.

IX. The industries, through associations and otherwise, when submitting problems for research, would facilitate the work if they were to make reasonable provision for the financial reimbursement of the university for its expenditure of time, effort and material, and thereafter provide for suitable stimulus and encouragement for expansion of cooperative effort, such as endowments, fellowships and the like.

RECOMMENDATION

In view of the foregoing, this committee is unanimous in recommending that the American Chemical Society take the initiative in creating the committee suggested in Conclusion III.

Respectfully submitted,

CHARLES BASKERVILLE, *Chairman*
W. S. ALLEN,
VIRGIL COBLENTZ,
GEO. A. HULETT,
E. G. LOVE,
RUSSELL W. MOORE,
MAXIMILIAN TOCH,
J. C. OLSEN,
F. G. WIECHMANN

DR. UGO SCHIFF

THE recent death of Dr. Ugo Schiff, professor of chemistry in the Royal Institute of Florence, recalls to mind that historical meeting of chemists which convened in Karlsruhe in 1860. The classical work of Stas on atomic weights published about this date had caused much discussion as to the real significance of these constants. There was, however, no uniformity in regard to the choice of equivalents, with the result that great confusion existed in the selection of formulas of compounds. Thus the formula for even so simple a substance as water will be found in the writings of the chemists of this period designated variously as H_2O, H_2O_2 and HO, while the more complex compounds were sometimes represented by a score or more of different formulas. In order to discuss this unfortunate situation and with the hope that some system might be brought out of the chaotic condition, Kekulé and a few of his associates called a meeting of the great chemists of Europe. This meeting convened in Karlsruhe in 1860. It was here, after much discussion, that Cannizzaro delivered that now justly renowned address in which he pointed out that all confusion would disappear if we but accept in its entirety the hypothesis advanced by his fellow countrymen, Avogadro and Ampere. The address was published in pamphlet form and distributed among the chemists present. The effect of the address may be judged from the following quotation[1] from Lothar Meyer:

> I too got a copy which I put in my pocket to read on my home journey. I read it again and again and was astonished at the light which the writing threw on the most important points at issue. The scales fell from my eyes, doubt vanished and a sense of the calmest certainty took its place.

For a number of years preceding his death Schiff was the only living representative of that remarkable body of men who attended this conference. The mention of his name to any of the chemists in Europe was almost certain to bring the reply that he was the only

[1] Armitage, "A History of Chemistry."

chemist living who had attended the famous meeting at Karlsruhe in 1860.

I chanced to visit Professor Schiff's laboratory at Florence in 1913 and found him a delightful gentleman, who, although over eighty years of age and suffering greatly from the gout was still able to give his course of lectures. He spoke with feeling of his friendship for some American chemists, especially for the late Professor Caldwell, of Cornell University, whom he had met while the two were students together in Woehler's laboratory at Göttingen.

Professor Schiff was a German and educated in German universities. He was compelled to leave his native land, however, because of his rather advanced political views and went some forty years ago to the Royal Institute of Florence, where his brother was professor of physiology. Professor Schiff made numerous contributions to chemistry and was the discoverer of the compounds known as Schiff's bases. He had no use for physical chemistry and would not allow the use of electricity in his laboratory. This recalls the fact also that Professor Baeyer's laboratory at Munich did not include any laboratory devoted to physical chemistry until 1913, when a small room was fitted up for this work.

William McPherson
Ohio State University

SCIENTIFIC NOTES AND NEWS

Dartmouth College has conferred the degree of doctor of laws on Ernest Fox Nichols, retiring president of the college, who has resigned to accept a chair of physics at Yale University.

Dr. William H. Welch, professor of pathology at Johns Hopkins University, received the honorary degree of doctor of laws from the University of Chicago at the commencement exercises.

Yale University has conferred its doctorate of science on Dr. Theobald Smith, of the Rockefeller Institute for Medical Research, and the degree of master of arts on Professor A. D. Bevan, of the Rush Medical College.

In conferring degrees of doctor of science and master of arts, respectively, at the Harvard University commencement exercises, President Lowell said:

> Richard Pearson Strong, knight errant of these latter days, armed not like the knights of old, but with the power of science, yet running greater risks than they; destroying dragons invisible to mortal eye, and saving not one or two, but hundreds and thousands by his art.
>
> Ernest Henry Wilson, a botanist, who has explored the flora of the Chinese-Tibetan land, and enriched with many Asiatic shrubs and trees the gardens of the western world.

Dr. Harmon N. Morse, professor of chemistry in the Johns Hopkins University, has received the doctorate of laws from Amherst College, from which he graduated in 1873.

The degree of doctor of science was conferred on Dr. Ludvig Hektoen, director of the Memorial Institute for Infectious Diseases, Chicago, by the University of Wisconsin, at the commencement on June 21.

The honorary degree of doctor of science was conferred on John J. Carty, of New York, chief engineer of the American Telephone and Telegraph Company, at the commencement of Bowdoin College.

Dr. Edward J. Nolan was given the degree of doctor of science by Villanova College at the last annual commencement, in recognition of his many years' service as librarian and secretary of The Academy of Natural Sciences of Philadelphia.

At the recent commencement the University of Pittsburgh conferred the honorary degree of doctor of laws on Dr. Otto Klotz, Dominion astronomer, Ottawa.

Dr. N. A. Cobb, of the Department of Agriculture, has received from the National Association of Cotton Manufacturers a medal "for his work in establishing methods of determining the properties and value of cotton."

On King George's birthday many titles were conferred, among them that of knight on the following scientific men: Dr. G. T. Beilby, F.R.S., the chemist; Dr. M. A. Ruffer, formerly professor of bacteriology at Cairo Medical

School; Dr. J. J. H. Teall, F.R.S., late director of the Geological Survey of Great Britain; Mr. R. F. Stupart, director of the Meteorological Service of Canada, and Dr. N. Tirard, medical editor of the "British Pharmacopœia." Dr. W. Baldwin Spencer, F.R.S., professor of biology in the University of Melbourne, was made a K.C.M.G. and Dr. Christopher Addison, parliamentary secretary to the ministry of munitions, and late professor of anatomy in the University of Sheffield, a privy councillor.

PROFESSOR ARTHUR SCHUSTER, honorary professor of physics at Manchester, has been appointed Halley lecturer at Oxford.

AT the meeting of the British Association to be held at Newcastle-upon-Tyne, beginning on September 5, evening lectures will be given by Professor W. A. Bone, F.R.S., on "Recent Advances in Combustion," and by Dr. P. Chalmers Mitchell, F.R.S., on "Evolution and the War."

DR. CHARLES HORACE MAYO, of Rochester, Minn., was elected president of the American Medical Association at the recent Detroit meeting. Dr. William J. Mayo, his brother, was president in 1906.

THE National Society for the Promotion of Engineering Education held its annual meeting at the University of Virginia from June 19 to 22, under the presidency of Professor Henry S. Jacoby, of Cornell University.

AT the annual meeting of the Eugenics Research Association held at Cold Spring Harbor on June 22, Professor Adolf Meyer was elected president in succession to Professor J. McKeen Cattell. The association will join in the Convocation Week meeting of the American Association in New York at the end of the present year.

FRANCIS C. SHENEHON, for the past seven years dean of the college of engineering and professor of civil engineering in the University of Minnesota, has tendered his resignation to the board of regents. Mr. Shenehon will devote his entire time to his practise as a consulting hydraulic engineer.

PROFESSOR CHAS. H. TAYLOR, head of the department of geology in the University of Oklahoma for the past five years, has resigned, to devote himself to his oil interests and to scientific research.

DR. A. D. EMMETT, assistant chief in animal nutrition, of the Illinois Agricultural Experiment Station at the University of Illinois, has accepted the position of research biological chemist in the research laboratory of Parke, Davis and Company, Detroit, Michigan.

PROFESSOR CALVIN O. ESTERLY, of Occidental College, is to go to the Scripps Institution for Biological Research of the University of California at La Jolla, as zoologist.

DR. FRANK E. LUTZ, of the American Museum, and Mr. J. A. G. Rehn, of the Philadelphia Academy of Natural Sciences, plan to spend July and part of August making a field study of the insect fauna of the isolated mountains southwest of Tucson, Arizona.

To study the return of plant life on an Alaskan volcano, Professor Robert F. Griggs, of the department of botany of the Ohio State University, accompanied by his family, left recently for Mt. Katmai, a volcano near the western coast of Alaska. The eruption of the volcano four years ago destroyed every vestige of plant life in the vicinity.

EDWARD P. VAN DUZEE has resigned his instructorship in entomology at the University of California, to accept the appointment of curator of the department of entomology of the California Academy of Sciences.

DR. JOSEPH A. LONG, assistant professor of embryology in the department of zoology, University of California, has been granted a year's leave of absence. He plans to remain in residence in the laboratories of the department of anatomy in order to continue certain researches on the ovulation of mammals and the earliest development of the mammalian ovum in conjunction with Professor Herbert M. Evans.

IN connection with the Quarter-centennial Celebration, held at the University of Chicago, June 2–6, 44 of the 82 doctors in botany returned to the departmental conference. At the formal conference, the papers representing

the doctors were as follows: "Genetical Phenomena in *Œnothera*," George H. Shull (1904), Princeton University; "A Quarter-century of Growth in Plant Physiology," Burton E. Livingston (1901), Johns Hopkins University; "The Problems of Plant Pathology," Frank L. Stevens (1900), University of Illinois, and "Inland Associations of Algæ and their Controls," Edgar N. Transeau, Ohio State University.

At the University of Illinois College of Medicine, Chicago, during the graduate summer quarter (June 20–September 12), in addition to the scheduled courses, a series of lectures will be given before the faculty and students to which physicians and all others interested are especially invited. The series will include about twenty lectures upon special research topics in the preclinical sciences by men from various institutions throughout the country. The opening of the graduate quarter will occur on June 20 and the first lecture of the series will be given on that date at 11 A.M. by Dr. Frank Billings, his subject being "The Relation of Graduate Work in the Fundamental Sciences to Clinical Study." President James will preside and will give an introductory address on "Graduate Work in Medicine."

Sylvanus Phillips Thompson, professor of physics in the Finsbury Technical College, London, known for his contribution to physics and electrical engineering, died on June 13, aged sixty-five years.

We learn from *Nature* of the death of M. Paul Lemoult, until the outbreak of war professor of chemistry at the University of Lille, and director of the School of Commerce of the North, and chief engineer of the chemical works of La Pallice, near La Rochelle. When Lille was occupied by the Germans some of the industries were transferred to the Lyons district, and under the direction of Professor Lemoult a picric acid works was erected. On May 1, a fire broke out in the works, and very soon assumed serious proportions. Lemoult was soon on the spot, but, in spite of his efforts, the fire spread to the storehouse, which contained 150 tons of picric acid. The explosion which ensued destroyed the factory, and Lemoult lost his life.

Two members of Lord Kitchener's party, who were lost with him, were Sir H. F. Donaldson and Mr. L. S. Robertson. Sir Frederick Donaldson was chief technical adviser to the ministry of munitions. He was president of the Institution of Mechanical Engineers in 1913. Mr. Leslie S. Robertson, assistant to the director of production in the ministry of munitions, was secretary of the Engineering Standards Committee.

The lectureship in animal embryology at the University of Cambridge will not be filled now, the balance of the benefaction (about £300) accruing since the death of Dr. Assheton, the late lecturer, being applied to completing and publishing the embryological work on which he was engaged.

Addresses at the dedication of the Van Vleck Observatory at Wesleyan University on June 16 were made by Dr. George Ellery Hale, director of the solar observatory of the Carnegie Institution, on "Astronomical Research as National Service," and by Professor Edward Burr Van Vleck, of the University of Wisconsin, on "John Monroe Van Vleck." The tablet on the building bears the inscription:

> This Observatory, the gift of Joseph Van Vleck, commemorates the services rendered to Wesleyan University 1853–1912 by his brother John Monroe Van Vleck, professor of mathematics and astronomy.

A tablet was unveiled on June 20 to the memory of Dr. Leonard Pearson, formerly professor in the University of Pennsylvania veterinary school and dean of the faculty. The exercises were held in the library of the veterinary school. Addresses were made by Dr. Louis A. Klein, dean of the veterinary school; Dr. William H. Caldwell, secretary of the American Guernsey Cattle Club, and Dr. C. J. Marshall, state veterinarian. The tablet was presented on behalf of the Guernsey Breeders' Association by Dr. Ephriam T. Gill, and was accepted for the university by Provost Smith. The tablet reads: "To the memory of Leonard

Pearson, B.S., V.M.D., M.D., eminent as a veterinarian, scholar and lover of mankind, through whose breadth of vision and untiring efforts these buildings were made possible; whose appreciation of the needs of animal husbandry kept him in sympathetic touch with the farmer, and whose achievements will always be an honor to his alma mater, this tablet is affectionately dedicated by the Guernsey Breeders' Association."

THE will of Mrs. Helen C. Julliard gives $50,000 to the American Museum of Natural History, $25,000 to Colorado College, $100,000 each to St. John's Guild and the Lincoln Hospital, and $50,000 to the New York Orthopedic Hospital.

THE Guggenheim brothers, associated as M. Guggenheim Sons and Co. and in the American Smelting and Refining Company, have added $165,000 to their donations to Mount Sinai Hospital, making their total gifts in memory of their parents $665,000.

ANNOUNCEMENT is made of a gift to the Johns Hopkins Hospital of the sum of $95,000 by Dr. Kenneth Dows, of New York. The money is to be devoted to the investigation of tuberculosis and the better teaching of physicians and students in the recognition and management of the disease and the care of the patients who seek treatment for it at the hospital.

UNIVERSITY AND EDUCATIONAL NEWS

MEMBERS of the Du Pont family, who are alumni of the Massachusetts Institute of Technology, have given $800,000 for the extension and maintenance of the new buildings. Four other alumni—Charles Hayden, C. A. Stone, E. A. Webster and Edward B. Adams—have subscribed sums amounting to $200,000. It is understood that the anonymous donor who has already made large gifts to the institute has undertaken to give five dollars for each three dollars subscribed by the alumni during the present year.

IT is planned to hold the annual meeting of the American Association of University Professors in New York City on Friday and Saturday, December 30 and 31. Further details will be published in the October number of the *Bulletin* of the association.

DR. WALTER EUGENE GARREY, for some time connected with the department of physiology of the Washington University, St. Louis, Missouri, has been elected to the chair of physiology in the college of medicine of Tulane University of Louisiana.

PROFESSOR JAMES F. NORRIS, head of the department of chemistry at Vanderbilt University, Nashville, Tenn., has resigned to accept a professorship of general chemistry at the Massachusetts Institute of Technology. He will be immediately associated with the instruction to be given in the fourth and fifth years of the new course in chemical engineering just established. Professor Frank H. Thorp, of the institute, has resigned his assistant professorship of industrial chemistry, and expects to devote himself in the immediate future to private business.

DR. ROSS AIKEN GORTNER, from 1909 to 1914, resident investigator in biological chemistry at the Station for Experimental Evolution of the Carnegie Institution and since that time associate professor of soil chemistry in the division of soils of the University of Minnesota, will transfer, on August 1, to the division of agricultural bio-chemistry in the same institution, with the title of associate professor of agricultural bio-chemistry, in charge of the section of bio-chemical research.

LESLIE ALVA KENOYER, Ph.D. in botany from the University of Chicago, has been appointed to a professorship in biology at Ewing Christian College, Allahabad, India, and is sailing from Vancouver on June 29.

DISCUSSION AND CORRESPONDENCE

THE ACCEPTED FACTS OF DYNAMICS

OF those who have contributed to the recent discussion in SCIENCE concerning the methods of presenting the laws of dynamics, all would

undoubtedly solve actual problems with accordant results. If this is true it is evident that the disagreement is largely a matter of words rather than of principles, and that if all understood one another a large part of the apparent disagreement would vanish. Most of us find it difficult to give the same careful consideration to propositions advanced by others that we expect them to give to our own. The habitual use of a certain routine tends to give the mind a "permanent set" which makes it difficult to appreciate the fact that equal familiarity might prove another routine to be equally effective. One who is strenuously opposed to a particular method will find it a useful exercise to adopt that method temporarily and apply it to actual problems in sufficient number and variety to make him thoroughly familiar with it.

I have not the slightest doubt that the routine favored by Mr. Kent[1] can be used effectively in teaching students to state correctly the solutions of problems in uniformly accelerated motion. Neither have I any doubt that the method outlined by me[2] can be used with equal effect. In the explanation of the fundamental equation the two methods are in fact identical, except as regards the matter of the choice of units. Mr. Kent apparently believes that the adoption of a particular set of units[3] is essential to the success of his method, while I believe it to be important to emphasize the fact that the choice of units is arbitrary and that Mr. Kent's units are no more easily understood than other systems which are in common use. To define units so that *unit force would give unit quantity of matter an acceleration of 1 foot per second per second* seems to me to be as simple and as easily understood as the definition *unit force is the force which would give unit quantity of matter an acceleration of 32.1740 feet per second per second.* The two definitions are based upon the same fundamental principle, and it would seem that a very effective method of helping the student to grasp the real significance of this principle is to give him plenty of practise in applying both definitions and in reducing forces and quantities of matter from one unit to another.

The chief remaining difference between Mr. Kent and myself is a verbal one: It seems to me undesirable (because obstructive of clear thinking) to designate two distinct physical quantities such as "quantity of matter" and "earth-pull" by the same name when there is an easy way to avoid it; but I have no expectation of converting Mr. Kent to my opinion on this point.

The method advocated by Professor Huntington can also without doubt be made effective if used with due persistence by an enthusiastic teacher like himself. The peculiar feature of this method is that it purports to be independent of mass. The eleven propositions which embody the latest presentation of the method[4] are in fact free from any adequate explanation of mass; but until the omission is supplied the sufficiency of these propositions can not be granted. The question of their sufficiency may be put to a simple test: Do they suffice for the solution of problems like the following:

A certain body has an acceleration of 10 ft./sec.^{2} when acted upon by a force F, and a second body has an acceleration of 15 ft./sec.^{2} when acted upon by an equal force F; if the two are combined into a single body, what acceleration will this body have if acted upon by a force F?[5]

[1] Science, December 24, 1915.

[2] Science, April 23, 1915, p. 609.

[3] Mr. Kent refers to the "good old principle, Unit force (pound) acting on unit mass (1 pound) gives it an acceleration of 32.1740 feet per second." As a matter of fact the antiquity of this "principle" is considerably less than that of the poundal (it was only in 1901 that the value 32.1740 feet per second per second was adopted by the International Conference of Weights and Measures as the most probable value of g at sea-level in latitude 45°); moreover it may be doubted whether this unit force has ever been employed practically. The really "good old" unit force is the weight of a pound mass (or kilogram mass) wherever the observer happens to be; this is still, and doubtless will continue to be, the unit employed in most practical applications.

[4] Science, March 3, 1916.

[5] The problem might be generalized as follows: A certain body has the acceleration a' when acted

The solution of such problems involves the use of a principle equivalent to the following: *The mass of a body is equal to the sum of the masses of the individual portions of matter composing it.* Professor Huntington doubtless accepts this principle (even if disapproving the language in which it is expressed); but nothing equivalent to it seems to be either expressed or implied in the eleven propositions given by him as sufficient. It is not merely that the word "mass" is not used; the term "standard weight" which replaces it is not defined or explained in such a way as to cover the above principle; there is no intimation that standard weight is the measure of an *additive property*[6] of matter—that *the standard weight of a body is the sum of the standard weights of its parts.*[7] But if this is not an

upon by the force F', and a second body has the acceleration a'' when acted upon by the force F''; a body formed by combining the two would have what acceleration when acted upon by a force F? For example, the addition of 1,000 tons to the load carried by a 5,000-ton vessel would have what effect upon the acceleration of the vessel when starting from rest with a given propeller action?

[6] Of additive properties which are invariable and possessed by *all* matter there are two: *inertia* and *gravitation*. These furnish two independent methods of making exact quantitative comparisons of different portions of matter. It is believed to be a fact that the two methods give results in exact agreement, but the basis of this belief is, and must be, precise experiment, as was explicitly recognized by Newton (although Mr. Kent apparently expects boys to learn it by watching the grocer weigh sugar). Comparing quantities of matter by weighing would involve only the property of gravitation if the earth were at rest; because of the earth's rotation it involves also the property of inertia. (The word inertia is here used in a quantitative sense for lack of a less objectionable term.)

[7] Proposition 9 includes the statement that standard weight is "characteristic of the given body," and proposition 3 the statement that "if any material is added to or taken away from the body it ceases to be the same body"; but there is no intimation that the addition of matter to a body may not produce a body of less standard weight than the original body.

essential part of the principles of dynamics as actually interpreted in solving problems, I would be glad to know how it can be dispensed with in the case of the particular problem stated above.

The point which Professor Huntington's method of statement evades is brought out clearly also by the following citations from former articles in SCIENCE:

Professor Huntington's view:[8] The statement: "Body A has three times the mass of body B" is precisely equivalent to the statement: "Body A requires three times as much force as body B to give it a specified acceleration."

Ordinary view as understood by me:[9] The statement that "body A has three times the mass of body B" means more than that "body A requires three times as much force as body B to give it a specified acceleration"; it means that the material contained in body A might be made into three bodies, each of which would require the same force as body B to give it a specified acceleration.

If the latter view is correct, it shows clearly the appropriateness of the words "quantity of matter" as a brief definition of mass.[10] If it is not correct, I would again ask how it is possible to solve problems such as the one given above.

If a proposition expressing the fact that the standard weight of a body is equal to the sum of the standard weights of its parts is added to Professor Huntington's eleven numbered statements, the scheme becomes indeed logically "sufficient" as an explanation of the fundamental equation of motion. It is also, of course, logically redundant, all that part referring to gravity being irrelevant as regards the real meaning of the laws of dynamics. This redundancy is not necessarily objectionable

[8] SCIENCE, July 30, 1915, p. 159.

[9] SCIENCE, September 10, 1915, p. 341.

[10] The significance of the words quantity of matter in dynamics was discussed in a former communication (SCIENCE, September 10, 1915). A fuller analysis is given in an article published in the *American Mathematical Monthly*, February, 1916.

in a preliminary explanation, but the fact should finally be made clear that the second law of motion is quite independent of the law of gravitation and of the facts of terrestrial gravity. The fact that the word weight is usually associated with gravity makes the term "standard weight" misleading and inappropriate as the name of a "characteristic of the given body" which has nothing to do with gravity.[11]

Full comment on the latest communications of Mr. Kent and Professor Huntington would consist largely of the repetition of comments made in previous communications by myself and others, and I shall take space only for a remark regarding their attitude toward the equation $F = ma$. They agree in objecting most strenuously to the use of this equation. The grounds of the objection as stated by Professor Huntington are that it implies "a perfectly arbitrary choice of units" and a choice that is "needlessly complicated and quite unscientific." When these objections are considered in connection with the units endorsed by both Mr. Kent and Professor Huntington, the implication seems to be that it is less arbitrary, less complicated and more scientific to define a unit force as "the force which would give the unit mass 32.1740 units of acceleration" than as "the force which would give the unit mass one unit of acceleration." What reason there is for such a supposition it is not easy to see.

The fact that the choice of units is always arbitrary is indeed a very important fact to emphasize with students, and probably the only way to do this effectively is to give practise in the use of different sets of units in solving the same problems. If any author states or implies that the unit force *must* be defined as the force which would give unit mass unit acceleration, he makes an unfortunate mistake; but the same may be said of one who states or implies that the force which would give a unit mass 32.1740 units of acceleration is other than an arbitrarily chosen unit.

L. M. Hoskins

Stanford University,
April 8, 1916

[11] This inappropriateness is strikingly apparent in referring to astronomical masses. In a recent lecture by an astronomer of high reputation the statement was made that the sun contains more than 97 per cent. of the matter in the solar system. How would this fact be expressed by Professor Huntington? Would he speak of the "standard weights" of the sun and the solar system?

ELECTRICAL ACTION AND THE GRAVITATION CONSTANT

In Science for December 31 Professor Nipher suggests that previous determinations of the gravitation constant may be in error, owing to the force action of electric charges on the attracting masses. The point is interesting, but in estimating the possible magnitude of the effect the author seems to have committed a serious error.

He puts the charge Q on a sphere equal to RV, where R is the radius and V is the *absolute* potential of the sphere. But this equation holds only when the sphere is alone in space; otherwise it may be nowhere near true. Consider, for instance, an insulated uncharged sphere inside a closed metal box. By charging up the box we may change the absolute potential of the sphere by a large amount without placing any charge whatever upon the sphere itself.

If Professor Nipher really has made this slip, he is at least in august company. For no less an authority than Boltzmann fell into a similar error, when he set the capacity of a conducting molecule *between two conducting plates* equal to its radius.[1]

In the classical experiments on the gravitation constant charges certainly existed on the attracting masses, in consequence of contact potentials between metals if for no other reason. But Professor Nipher's calculation indicates a possible error due to contact potentials of only a per cent. or two. Furthermore, the electric effect would be enormously influenced by the nature and arrangement of other parts of the apparatus, and these have varied widely. It seems doubtful, therefore, whether the actual error due to this cause can exceed the very

[1] Gastheorie, I., p. 79.

small discrepancies between the best modern determinations of the constant.

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GRAVITATION AND ELECTRICAL ACTION

IN a recent number of SCIENCE[1] Professor F. E. Nipher has pointed out that the force exerted between two isolated solid spheres depends not only upon their mutual gravitational attraction, but also upon the electrostatic charges carried upon their surfaces, and suggests that this fact has been ignored in determinations of the gravitational constant by experimenters from Cavendish to Boys. The fact that the potential of the earth relative to points infinitely remote is not necessarily zero, and the further fact that the earth's surface may at a given time and place be heavily charged owing to volume changes in the atmosphere are urged to show that the spheres employed in the experiments referred to may have carried appreciable charges.

That Professor Nipher's expression for the electrostatic force between two charged spheres is applicable only to the case in which the distance between their centers is great compared with the radius of the larger is perhaps of little importance in view of the fact that the torsional systems in all experiments on the gravitational constant have been effectively shielded from electrostatic action. The important condition is, of course, that displacements of the torsional system shall not alter the electrostatic capacity of the earth, or of the earth-atmosphere condenser, and this condition is satisfied when the system is surrounded by a conducting casing. In Boys' experiment the torsional system was enclosed in a double metal casing and the apparatus was installed in an underground vault.

It does not seem impossible that contact differences of potential between the parts of the torsional system and the casing may have affected results in some of the experiments, although in Boys' experiment the symmetry of the apparatus was such that forces arising from contact differences of potential could have exerted only inappreciable torques on the suspended system.

There would seem to be little reason for thinking that the gravitational constant is not known to within one part in 3,000, Professor Boys' estimate.

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[1] March 31, 1916, page 472.

AMBYSTOMA NOT AMBLYSTOMA

IN view of the recent difficulty I have experienced in trying to have the generic name of the spotted salamander spelled *Ambystoma* as originally written by Tschudi, it seems desirable to call attention to the correct form of the word. In reporting the exhibition of a specimen of this salamander before the Biological Society of Washington I took pains to see that the word was correctly spelled in manuscript. The report has appeared in print twice and in each instance an *l* has been inserted by the publisher.[1]

The word was proposed by Tschudi[2] in 1839 and written by him *Ambystoma* in four different places in his work, and only in that manner. The derivation of the word is not given by him and there is nothing to indicate that he intended *Amblystoma* and made a lapsus calami. The first author to employ *Amblystoma* was Agassiz[3] in 1842–1846. This spelling has had a very wide acceptance and it is the one usually employed by morphologists, embryologists, physiologists and others who are not systematists. A discussion of the appropriateness of *Ambystoma* and its possible derivation from ἀνὰ στόμα βύειν meaning to cram into the mouth is given by Stejneger in his "Herpetology of Japan."[4] The correct form of the word is employed by Hegner[5] in his "College Zoology," but aside from this most of the non-specialist authors that I have lately seen incorrectly spell the word with the *l* inserted.

[1] *Jour. Wash. Acad. Sci.*, Vol. 6, p. 258, May 4, 1916. SCIENCE, N. S., Vol. 43, p. 761, May 26, 1916.

[2] *Mém. Soc. Sci. Nat. Neuchatel*, Vol. 2, section 4, pp. 57 and 92, 1839.

[3] Nomencl. Zool. Rept., p. 2, 1842–46.

[4] *Bull. U. S. Nat. Mus.*, No. 85, p. 24, July 22, 1907.

[5] "College Zoology," p. 511, 1912.

Dr. Stejneger has called my attention to the fact that the specific name under which Mr. Doolittle's specimen was reported should properly have been written *Ambystoma maculatum* instead of *Ambystoma punctatum*, as shown by him in 1902.[6]

M. W. Lyon, Jr.
George Washington University

CENTIGRADE VERSUS FAHRENHEIT

In the article by A. H. Sabin, appearing in the May 5 issue of Science, entitled "The Centigrade Thermometer," were expressed the sentiments of many scientific workers, who have had no other method of voicing their opposition to his scheme accorded to them by Representative Johnson, than through articles in various publications.

In the judgment of the writer the set of questions submitted to him by Mr. Johnson should have been so constituted as to have permitted the views of the opposition to have been presented.

The *inconvenience* of the Fahrenheit scale is not apparent to the writer.

The number denoting the temperature range between the freezing point (32°) and the boiling point (212°) of water, being 180 is divisible without a remainder by 1, 2, 3, 4, 5, 6, 9 and 10; while the number for the Centigrade scale denoting the same range, namely 100, is divisible by only 1, 2, 4, 5 and 10 without a remainder; or three less divisors, tending to arouse the suspicion that the Fahrenheit scale is more "rational" than the Centigrade scale.

It is the opinion of the writer that such a change as is contemplated by Mr. Johnson would not only be idiotic, but a most undesirable blow at *educational efficiency*, the most important factor entering into the life of every human individual.

F. E. Austin
Hanover, N. H.

SAFETY RAZOR BLADES FOR HAND SECTIONING

If there are still any botanists so old-fashioned as to cut sections by hand, they may be glad to know, both for themselves and for their students, of the convenience and cheapness of the razor I am now using.

The present stropping handle of the Gem Safety Razor is the holder, the Gem Damascene the blade. The total cost is about fifteen cents. The blades, when dull, can be replaced for five cents, but in the stropping holder they may very easily be kept sharp.

I find this thin, keen, easily stropped razor admirably suited to light work. I am not sure that it would be heavy enough to cut hard wood satisfactorily, but it sections leaves, stems and roots, even of considerable size and hardness. I am so pleased with the result that I wish to share it.

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SCIENTIFIC BOOKS

Ptolemy's Catalogue of Stars. A Revision of the Almagest. By C. H. F. Peters and E. B. Knobel. Carnegie Institution of Washington, 1915.

It will give pleasure to astronomers to have this long and careful work on the collation of existing manuscript copies of the "Almagest" so well presented in published form. It is the oldest known catalogue of measured star places, and while observers of this day can receive little assistance in comparing those rough measurements with modern positions, the catalogue will still exhibit the changes in the heavens due to precession, and it serves as a record of the unchanging character of the distribution of the bright stars.

No original copy of Ptolemy's "Almagest" is in existence, so far as known, and the earliest manuscripts thus far found were made eight or nine centuries after the epoch of the catalogue. Both Greek and Arabic manuscripts are among the early transcripts; the Latin copies were translations of either one of these. In the transcriptions many errors were made, due in part to the ignorance of astronomical science on the part of copyists, and to the difficulties of translating the nu-

[6] *Proc. Biol. Soc. Wash.*, Vol. 15, pp. 239–240, December 16, 1902.

merical terms of the original, some of which can easily be misconstrued unless the form is exactly noted. To reconcile if possible the differences in the various manuscripts, and then to identify the stars observed with the present known positions, were the objects of the revision. Any probable explanation of the source of an error makes it easier to accept a correction, and for such explanations a thorough acquaintance with the language in which the results were recorded, as well as knowledge of the character of the results are required. Both these requirements were fulfilled in a remarkable degree by Dr. Peters. Grounded in his astronomical training under the tutelage of Encke and Gauss, he possessed the painstaking and thorough habits of the mathematical investigator, joined to a wide culture from his varied life in different European countries. His residence of several years at Constantinople gave him a fluent knowledge of Turkish, Persian and Arabic, besides his training in Greek, Latin and Hebrew, and his acquaintance with the usual European languages, which the old time culture demanded of an educated man. Following his revolutionary experiences, he came to this country in 1854, and soon after was associated with Dr. B. A. Gould, in the Dudley Observatory at Albany, which he left to become professor of astronomy at Hamilton College. In the period of over thirty years of his directorship of the observatory at Clinton, he made several trips abroad, and searched the capitals of Europe for the manuscripts of the "Almagest," sparing neither time nor labor in studying every detail relating to the star positions on record. The "Almagest" contained a full summary of all existing knowledge of the apparent movements of the sun, moon and planets, the division of practical astronomy to which the attention of the earliest students of the sky would be most naturally attracted. The seventh and eighth books were devoted to the catalogue of northern and southern stars, respectively. Ptolemy did not accept any other explanation of the universe than that of a central earth, without rotation, though ideas more in conformity with the actual form of the solar system had even at that time been more than once subjects of speculation. The value of the obliquity of the ecliptic was known, and the effect of the precession could be closely calculated. His positions were given in longitude and latitude, for an epoch known to be about A.D. 138. But the earliest comparisons of his positions showed that they were approximately true for a much earlier period, following the epoch of the observations of Hipparchus by about one hundred and ninety years, thus corresponding nearly to the epoch A.D. 60. The present publication, while presenting much of the evidence from all points, adds nothing to the solution of the question whether the places of Ptolemy's catalogue were derived from any observations of his own, or were simply the observations of Hipparchus, brought up to the later epoch by the addition of a constant correction to the longitudes, for the effect of precession.

After Dr. Peters had begun his study of the foreign manuscripts, Mr. E. B. Knobel, at one time president of the Royal Astronomical Society, learned that they were both engaged upon the same search; and as Dr. Peters did not plan to work in the English museums and libraries, they entered into hearty and unselfish plans of collaboration, to include all available sources of authority.

The description of their mutual labors has been written by the English astronomer, and the results have been tabulated by him, after much extra discussion and transcription of the original notes of Dr. Peters. In all, thirty-two copies of the "Almagest," now preserved in Rome, Paris, Vienna, Venice, Oxford and London, were examined by the two investigators, and the places of the stars from twenty-six of these manuscripts have been tabulated for comparison. The magnitudes from seven manuscripts have also been tabulated. The stars have been given Baily's numbers, consecutively, to No. 1,028, through the various constellations in which the catalogue of Ptolemy was collected. The places and

magnitudes are always those derived by Dr. Peters; and the identification with modern star designation, a tabulation of the errors found, and the comparison with the Harvard photometric magnitudes have been added. The fact that Ptolemy lived at Alexandria, four degrees south of Rhodes, the site of Hipparchus's observations, and yet did not include any more southern stars than did the latter, is one point of evidence against a new series of observations by Ptolemy. Hipparchus is supposed to have observed 1,080 stars. The work of identification involved the reduction of modern star places back to the respective epochs of the old observations, and, with this, the computation of the probable errors of the old measures. These had been recorded in fractions of a degree, and the fact that much confusion arose in transcribing these fractions in the Greek has added to the uncertainty of some of the identifications. Many of the manuscripts in existence are evidently copied from some particular original, and the errors of that original would be reproduced, in addition to new mistakes of transcription.

After the death of Dr. Peters, in 1890, the collection of material made by him was sent to Mr. Knobel, who has enlisted the support of astronomers and public-spirited men in having the results of their joint labors properly recognized by the publication in permanent form. The volume contains an excellent portrait of Dr. Peters, and some photographic reproductions of the pages of the two oldest copies of the "Almagest."

R. H. Tucker

Lick Observatory,
March 21, 1916

Flora of the Northwest Coast. By Charles V. Piper and R. Kent Beattie. Published by the authors, Washington, D. C., November 10, 1915. Pp. xiii + 418. Price $1.50.

Students of the flora of western North America will welcome Piper and Beattie's "Flora of the Northwest Coast." The authors are to be congratulated for bringing to fruition the labors of their earlier years for the botany and botanical education on the Pacific coast. Their new work will contribute greatly to the knowledge of the plant life in the northwest and, as they themselves express the hope, will "stimulate a greater activity and interest in the flora."

The area covered by the manual is that lying west of the summit of the Cascade Mountains from the headwaters of the Willamette River in southern Oregon to the 49th parallel of latitude. This is a natural geographic region characterized by its magnificent coniferous forests which form the dominating plant formations over nearly the entire area below 5,000 feet altitude. "The only break in this coniferous cover consisted originally of a series of prairies extending from the Upper Willamette Valley northward to Vancouver Island. North of the head of Puget Sound, however, the prairies are small and limited in the main to the extremities of points and portions of the islands in the Sound."

In a forested region such as the northwest the lignescent flora naturally attracts attention, and it is interesting to note that, although the forests are largely composed of a few species of conifers, there is a comparatively large variety of trees and shrubs, approximately 9½ per cent. of the total flora. Of the 155 species of woody plants described, 47 are trees, 105 shrubs and 3 woody climbers. The genera with more than two species of trees are, *Pinus* 6, *Abies* 6, *Salix* 5, and *Acer* 3. The genera with five or more species of shrubs are, *Salix* 14, *Ribes* 10, *Spiræa* 5, *Rubus* 6, *Ceanothus* 6, and *Vaccinium* 9.

A summary of the flora is given in a table, from which we learn that there are described, 100 families, 550 genera and 1,617 species and subspecies, distributed as follows: Pteridophyta 7 families, 22 genera and 61 species; Gymnosperms 2 families, 10 genera and 22 species; Monocotyledons 15 families, 111 genera and 412 species; Dicotyledons 76 families, 407 genera and 1,122 species. The composition of the flora may be brought out a little more fully by listing a few of the prominent families and genera. The families containing more than 60 species are: Poaceæ 46 genera and 116 species,

Cyperaceæ 7 genera and 95 species, Cruciferæ 28 genera and 69 species, Rosaceæ 28 genera and 61 species, Leguminosæ 13 genera and 72 species, Compositæ 66 genera and 89 species. The genera containing more than 15 species are: *Agrostis* 18, *Poa* 22, *Carex* 73, *Juncus* 23, *Salix* 19, *Polygonum* 20, *Ranunculus* 19, *Lupinus* 19, *Trifolium* 20, *Epilobium* 18, *Erigeron* 17 and *Senecio* 17. All of these genera with the exception of *Trifolium* and *Lupinus* are common not only throughout the cooler parts of North America, but of Europe and Asia as well. In fact, while there are many endemic species, the general floral element is that of the Boreal Realm, just as we would expect, since the region lies within the Arctic to Transition zones. Very few of the typical American genera of the arid regions of the west are represented.

The text is supplied with keys to families, genera and species, but the descriptions of the species are often meager, too much so we fear in some cases for certain identification. But in the reviewer's mind the most disappointing feature of this admirable work is the extremely meager and indefinite distributional notes. It is to be regretted in this respect that the authors did not follow the excellent example set by the senior author in his "Flora of Washington," and give the zonal distribution. Two additional words would have been sufficient, and these with a little fuller definition of each zone in the preface would have been of great service to the student of plant distribution.

LEROY ABRAMS

NOTES ON METEOROLOGY AND CLIMATOLOGY

FROST

PROFESSOR ALEXANDER MCADIE and Mr. William G. Reed have each recently presented several papers on the meteorology of local frosts, the causes of frost damage to plants and methods of protection, the dates of occurrence of frost, and bibliography of frost in the United States.

The meteorology of frost formation is discussed by Professor McAdie in an article entitled "Temperature Inversions in Relation to Frosts."[1] Two laws of frost formation are enunciated as follows:

(1) Where the air is in motion, there is less likelihood of frost than where the air is stagnant; (2) frost is more likely to occur when the air is dry (and dustless) than when it is moist.

The first is true because local frosts are connected essentially with local "air drainage." Soon after sunset, cold and dense air, cooled chiefly by radiation to the ground, drains slowly down the slopes into the valleys and low places. Strong winds mix the air and so prevent the occurrence of local frosts. The second law is based on the retardation of temperature change due to moisture in the air. The water vapor strongly absorbs the heat rays from the earth, acting in this way as a blanket. If condensation occurs, there is further retardation of the cooling by the liberation of latent heat. Since dry air is denser than moist air at the same temperature, a loss or gain of moisture as well as a change in temperature affects the rate of "air drainage." To obtain a continuous record of the weight of water vapor in grams per cubic meter of air, Professor McAdie has devised a "saturation deficit recorder." This instrument is essentially a hygrograph mounted on the pen of a thermograph. The thermograph indicates the maximum weight of water vapor possible in the air at the temperature prevailing, and the hygrograph indicates the percentage of saturation.

Protection of plants from injury by frost involves the conservation of the earth's heat with covers, the addition of heat to the air, or the use of some agency with high specific heat, such as water, to prevent cooling. Preventable damage often results from too rapid defrosting in the morning; fortunately, the same agents which keep the temperature from falling retard its rise.

Mr. Reed treats the subject of protection as a whole in an illustrated article, "Protection from Damage by Frost."[2] The methods most successful commercially depend upon the com-

[1] *Annals*, Harvard College Observatory, Vol. 73, pp. 168 to 177, 4 pl., Cambridge, 1915; or see *Scientific Monthly*, December, 1915, pp. 293 to 301.

[2] *Geographical Review*, February, 1916, pp. 110 to 122.

bination of heat and smoke; in the best orchard practise there is a fairly clean-burning small fire to each one or two trees. Economical and effective use of heaters involves the information and warnings issued by the U. S. Weather Bureau, and knowledge of the local seasons of frost and places of lowest temperature. The methods of protection should be studied, and the type which has proved successful in the particular region or in one where the conditions are similar should be selected. The campaign should be carefully planned in advance. Protection is so expensive that crops of high value only can carry the charge.

Protection is but one aspect of the frost problem. The problem for the farmer is to determine the frost conditions he will have to meet and to arrange his crops and his agricultural practise to suit these conditions. Apparently, the first frost maps of the United States were made by Mr. P. C. Day.[3] Maps are presented showing average and extreme dates of the last killing frost in spring, and of the first in autumn, and the average length of the growing season. Isochronal lines are shown east of the Rocky Mountains, and figures are given at stations west of the mountains. Later, more extensive frost data, included in the original records of the cooperative observers of the Weather Bureau, were edited, and tabulated; and new frost maps of the United States have been constructed on a scale of 1/2,500,000, the records used being within the period 1895 to 1914. In this work the Office of Farm Management and the Weather Bureau cooperated. A preliminary study of these maps was presented by Mr. Reed at the Second Pan-American Scientific Congress. Parts of the author's abstract are quoted here:

> Killing frost . . . is a temperature low enough to destroy plant tissue. Frost is measured by the effect on plants, but it would be better to use some definite temperature.
>
> Most of the United States is subject to annual killing frosts. Low temperatures are most dangerous to plants at the beginning and end of the growing season. Frost is an anticyclonic phenomenon. East of the Rocky Mountains it is frequently possible to follow a frost across the country; west of the Rocky Mountains frost occurs when an anticyclone overlies the region.
>
> Records of frost occurrence are now available for over 5,000 places. These may be supplemented by knowledge of topography and vegetation, and although the term is of doubtful meaning, "average dates" of killing frost may be determined. Frost risks may be determined by the use of the "standard deviation." Maps of the average date of last killing frost in spring, and the frost killing in autumn, and of the length of the season without killing frost have been drawn. Between one quarter and one third of the country is subject to frost after June 1 and before September 1. Computed dates of last spring frost and first autumn frosts in nine years in ten, as well as the length of the season without killing frosts in four years in five, have been mapped.
>
> Mountain masses are more subject to frost than lower regions, but the relations are complicated by "air drainage," which makes frost more common in valleys than on slopes. . . .

Mr. Reed and Miss Cora L. Feldkamp have published a "Selected Bibliography of Frost in the United States."[4] It is arranged with the later papers first, as most of the work is very recent; earlier papers cover substantially the same ground. Thus 26 of the 94 articles are dated 1914 or 1915. An index by states is added. Although the titles are few in number, they were selected from all the material on "frost and frost prevention under American conditions," found in the libraries of Washington, the published bibliographies of the John Crear Library (Chicago), and references in many agricultural and meteorological magazines and other publications.

WEATHER AND THE WAR

There are two aspects of the relationships between weather and the war: weather has a decided control on military operations; but it is a question whether the war has any effect on the weather. Professor R. DeC. Ward has undertaken a thorough study of the former, and has published some of the results in the

[3] Weather Bureau Bulletin V., 1911, 5 pp., 5 maps.

[4] *Monthly Weather Review*, October, 1915, pp. 512 to 517.

Popular Science Monthly[5] and in the *Journal of Geography*.[6] The decrease in military activity at the opening of winter indicates the deterrent effect of winter weather on military operations. As the speed of movements in the field is dependent primarily on the condition of the ground, cold weather in winter is almost invariably accompanied by greater military activity. Since the Russian theater has colder and drier weather in winter than that in the west, operations there are less hindered by mud. On the other hand, in autumn the flooding rains present great difficulties in the east. The prospect of the usual autumnal rains and the intrenchment difficulties of the winter probably spurred the Germans and Austrians to their remarkable activity in the summer of 1915 even in spite of heavy mud.

At great altitudes, meteorological hindrances are much more acutely felt. High mountains mean cold and snow even in summer. Also mountains have more clouds, more rain and more thunderstorms than the lowlands. In winter, fighting is extremely difficult. Operations in the Alps, Carpathians, Balkans and Caucasus have almost always been mentioned in the same breath with the unfavorable weather conditions.

Furthermore, too great dryness makes operations difficult anywhere. Thus on Gallipoli peninsula and in Mesopotamia there was a scarcity of water, and the dust was almost unbearable in the summer dry season. The difficulties of operations in deserts are such as to make Egypt fairly safe from attack. The story of the operations in Mexico is not without mention of the winds, dust, sand and heat of the desert.

For air and naval engagements, foggy conditions are generally chosen. This has been shown abundantly in the Zeppelin raids on England, the aeroplane raids of the French in Germany, and in the infrequent naval attacks on coasts. For the use of asphyxiating gases, wind conditions must be just right: steady, moderate, and from the proper quarter.

On the effects of battles on rainfall, the excessive raininess of the winter of 1914 to 1915 in the British Isles and weather anomalies elsewhere have occasioned some comment. Charles Harding presented before the Royal Meteorological Society[7] a summary of the weather conditions for eight stations in Great Britain and eight continental ones for the period August, 1914, to April, 1915. In connection with the discussion as to the cause of the extraordinarily heavy rainfall which was experienced in England, Dr. H. R. Mill, director of the British Rainfall Organization, made the following statement:

> The vastness of the work done by the quiet processes of nature requires only to be realized in order to show the incalculable improbability of gunfire in France producing a wet winter in England. Take the case of the three and a half inches of rain which fell in excess of the average in December over 58,000 square miles of England and Wales. This quantity is 203,000 square mile inches or 13,126,920,000 tons. At winter temperatures, saturated water vapor would form about 1 per cent. of the mass of the atmosphere containing it, hence the minimum quantity of air which must have been carried over England and Wales in December, 1914, must have exceeded 1,300,000,000,000 tons. The amount of force required even to deviate the direction of moving masses of this magnitude is surely far beyond that which can be exerted even by nations at war.

Professor Cleveland Abbe in the *Popular Science Monthly*, January, 1911, shows by laboratory experiments that the firing of cannon or dynamite to produce rain can not possibly succeed. *The Scientific American*, October 24, 1914, contains an instructive article on the subject; and Professor McAdie in the *Scientific Monthly*, February, 1916, gives a brief summary of the question.

HEAVY SNOWFALL IN NEW ENGLAND

DURING the past winter the snowfall in parts of New England exceeded all previous records (since 1873) for any winter. The

[5] December, 1914, pp. 604 to 613.

[6] February, 1915, pp. 169 to 171; March, 1915, pp. 209 to 216; November, 1915, pp. 71 to 76; June, 1916, pp. 374 to 384.

[7] *Quarterly Journal*, October, 1915, pp. 337 to 348.

snowfall of the early winter was greater in the western than in the eastern part of New England, but not later, owing to the cooling of the ocean water.[8]

SNOWFALL, 1915 TO 1916 (INCHES)

	November	December	January	February	March	April	Total	Av. 1895 to 1913
Eastport, Me.....	T	4.4	14.2	21.8	15.7	6.5	62.6	87.2
Portland, Me.....	T	12.0	12.2	20.2	36.3	7.9	88.6	73.1
Boston, Mass.....	0.2	6.7	4.8	30.3	33.0	4.2	79.2	41.1
Blue Hill, Mass.[9]	1.0	12.3	6.4	33.4	42.2	16.2	111.5	58.2
Worcester, Mass.[9]	T	15.8	6.2	24.9	36.0	5.6	88.5	50.9
Albany, N. Y.....	0.1	40.3	0.6	13.7	37.9	2.1	94.7	46.0
Providence, R. I...	0.3	3.5	0.8	15.1	19.1	4.7	43.5	42.1
New Haven, Ct. ..	T	18.0	1.6	24.7	29.0	2.7	76.0	37.8

In New Haven the ground was snow-covered from February 3 to March 28, 1916. Two features prevented the occurrence of floods when the snow melted. First, on account of the lateness of the melting, the ground was thawed out below and so received readily the water from the melting snow. Second, the melting took place in clear, cool weather and lasted over a period of four days.[10]

The season ended with a fall of snow in eastern New England on April 28, amounting to eight inches at Blue Hill.

PROFESSOR CLEVELAND ABBE

At the annual meeting of the National Academy of Sciences held in Washington in April, 1916, Professor Cleveland Abbe was awarded its gold medal for "eminence in the application of science to the public welfare, in consideration of his distinguished service in inaugurating systematic meteorological observations in the United States." Unfortunately, on account of illness Professor Abbe could not be present to receive the medal in person. Since last June he has been incapacitated by partial paralysis for his work as editor of the *Monthly Weather Review*.

Professor Abbe, who is in his seventy-eighth year, has had forty-four years of distinguished service in government meteorology, a period significantly equal to the length of record of most regular Weather Bureau stations. Early in his career, Professor Abbe was an astronomer. On September 1, 1869, while he was director of the Cincinnati Observatory, he inaugurated daily weather reports for the Cincinnati Chamber of Commerce, which at once led the United States government to take up similar work. From 1871 to 1891 he was professor of meteorology and civilian assistant in the office of the chief signal officer, U. S. Army; and with the change of the weather service to a civil bureau in 1891 he continued as professor of meteorology in the Weather Bureau. As editor of the *Monthly Weather Review* from the time of its foundation to the present[11] Professor Abbe has been in touch with, and stimulated great numbers of meteorological observers and investigators. Although he was in a position to carry on but few original investigations, he did an immense amount of translation and compilation of the results of others' meteorological investigations. Among the more important of his works are: "Meteorological Apparatus and Methods" (1887); "The Mechanics of the Earth's Atmosphere" (1891 and 1909); and "First Report on the Relations between Climates and Crops" (1905, as of 1891).

To him belongs the credit of publishing a "Report on Standard Time" (1879) which started the agitation that resulted in the modern standard hour meridians from Greenwich.

Professor Abbe is a member of a great many domestic and foreign scientific societies, among them being five meteorological societies of Europe. Two signal honors from his con-

[8] See Science, February 11, 1916, p. 212.

[9] Sleet included; since January 1, 1909, regular Weather Bureau Stations have measured sleet separately. Thus, if sleet were included, the total for New Haven would be 82.3 instead of 76 inches.

[10] See article on snow-melting, by A. J. Henry, *Monthly Weather Review*, March, 1916, pp. 150 to 153.

[11] In the period 1909 to 1913, inclusive, the *Monthly Weather Review* was divided into two sections, the one which kept the title including the observational material, and the *Bulletin of the Mount Weather Observatory*, the discussional. Professor Abbe edited the latter only.

temporaries abroad are the degree of LL.D. from the University of Glasgow in 1896, and the Symons Gold Medal of the Royal Meteorological Society in 1912.

CHARLES F. BROOKS
YALE UNIVERSITY

SPECIAL ARTICLES

A NEW FORM OF PHOSPHOROSCOPE[1]

EXISTING phosphoroscopes are of two types, those with a periodically interrupted source of light and those employing a steady source.

To the first type belongs the classical instrument of E. Becquerel,[2] subsequently modified by E. Wiedemann,[3] in which the object is placed between two parallel revolving disks and is alternately illuminated and observed through properly placed and adjustable openings.

In 1908 Merritt,[4] devised a phosphoroscope in which the phosphorescent surface *P*, Fig. 1, was illuminated periodically by the passage

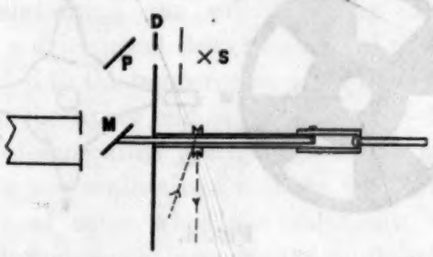

FIG. 1.

of an opening in a revolving disk *D* mounted between it and a source of light *S*. The phosphorescence was observed at the desired time after exposure by means of a small revolving mirror, *M*, mounted obliquely on the end of the shaft. The disk was carried upon a hollow sleeve revolving with the shaft and the angle between the opening in the disk and the plane of reflection of the mirror could be varied during rotation.

With this apparatus curves of decay of numerous cases of phosphorescence of short duration were determined by Messrs. Waggoner[5] and Zeller.[6]

In these phosphoroscopes, the source of light is not in itself necessarily intermittent, the periodic interruption of excitation being produced by the use of a revolving sectored disk. Another group of instruments of this general type employs the intermittent discharge from an induction coil or transformer, as in the spark-phosphoroscope briefly described by Laborde in 1869,[7] Crookes's device with sectored disk and commutator for observing the afterglow of substances subjected to kathode discharge,[8] Lenard's[9] phosphoroscope of 1892 and de Watteville's[10] apparatus for the spectroscopic study of phosphorescence (1906). Lenard's instrument differs from the others of this group in that the eclipse of the exciting spark is produced by the linear movement of a screen mounted upon the plunger of a Ruhmkorff mercury interrupter in the primary circuit of the induction coil.

The other type of phosphoroscope, in which an uninterrupted source of light is used, likewise had its origin with Becquerel.[11] It was later used for lecture demonstrations at the Royal Institution by Tyndall[12] and for measurements by Kester,[13] Waggoner[14] and others. It consists simply of a cylinder revolving on a

[1] A paper presented at the April meeting of the American Physical Society, 1916.

[2] E. Becquerel, *Annales de Chimie et de Physique* (3), 55, p. 5, 1859.

[3] E. Wiedemann, *Wiedemann's Annalen*, 34, p. 446 (1888).

[4] Nichols and Merritt, "Studies in Luminescence," Carnegie Institute of Washington, Publication No. 152.

[5] C. W. Waggoner, *Physical Review* (1), XXVII., p. 209.

[6] Carl Zeller, *Physical Review* (1), XXX., p. 367.

[7] Laborde, *Comptes Rendus*, 68, p. 1,576.

[8] Crookes, *Proc. of the Royal Society*, 42, p. 111 (1887).

[9] Lenard, *Wiedemann's Annalen*, 46, p. 637.

[10] C. de Watteville, *Comptes Rendus*, 142, p. 1,078.

[11] E. Becquerel, *Ann. de Chimie et de Physique* (3), 62, p. 5 (1861).

[12] See Lewis Wright, "Light," London, 1882, p. 152.

[13] Kester, *Physical Review* (1), IX., p. 164.

[14] Waggoner, Publications of the Carnegie Institution of Washington, No. 152, p. 120.

vertical axis, *A*, Fig. 2, and carrying a layer

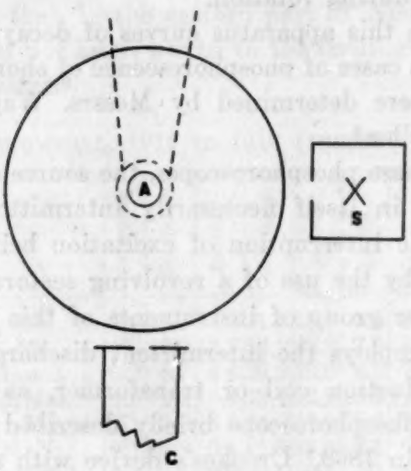

FIG. 2.

of the phosphorescent substance on its periphery.

A source of light, *S*, illuminates the traveling surface through a fixed vertical slit and the various stages of the phosphorescent glow may be studied by observing at different angles from this opening. In the form used by Waggoner, where a wheel of 45 cm. diameter was used instead of the small drum of Tyndall and of Kester this instrument has many advantages over other forms provided the substance is available in sufficient quantity to coat the entire rim of the wheel. With a speed suit-

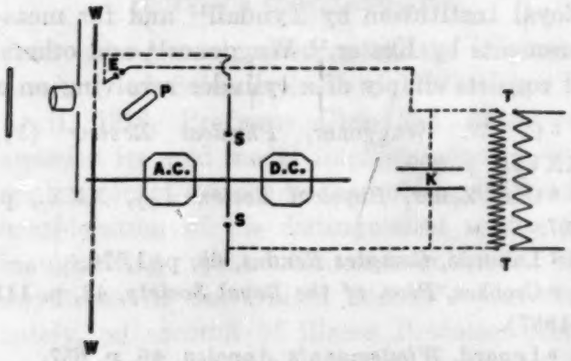

FIG. 3.

able to the substance under observation the whole phenomenon of the decay of phosphorescence may be viewed at a glance, including progressive changes of intensity and color.

The instrument, which we have called the *synchronophosphoroscope* and which is to be described in the present note, was devised for various studies in phosphorescence to which the previous types are not easily adaptable. It consists of a small synchronous, alternating-current motor A. C., Fig. 3, and a small direct-current motor D. C. upon a common shaft. To one end of the shaft is attached a sectored disk, *WW*, Figs. 3 and 4, with four equal open and four closed sectors, corresponding to the four poles of the A. C. motor. On a circuit of 60 cycles this machine, when brought to speed by the D. C. motor and released, runs steadily at 30 revolutions per second. A "step up" transformer *TT*, in the same alternating current circuit produces discharges at the spark gap, or series of gaps (*E*), at each alternation, *i. e.*, 120 times a second. This discharge may be reduced to a single spark by proper adjustment of the resistance and capacity of the circuit or more conveniently for many purposes the discharge may be confined to the peak of the wave by means of the four-pointed star-wheel, *SS* (Figs. 3 and 4), which is mounted

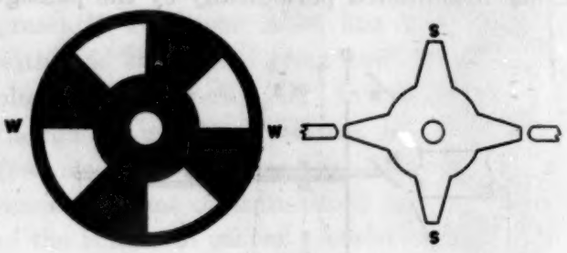

FIG. 4.

on the shaft and carefully adjusted as to phase.

The direct-current motor may also be used to drive the sectored disk at other speeds, in which case the circuit of the motor A. C. is broken and the discharge is derived from any convenient source capable of producing a proper spark at each quarter revolution.

When the sectored disk *WW* is so adjusted on the shaft that the closed sectors conceal the phosphorescent surface during excitation by the spark, an observer, looking through the open sectors as they pass, sees the phosphorescence as it appears a few ten thousandths of a second after. The apparatus is thus suitable for the study of phosphorescence of very short duration or of the earliest stages in cases of slow decay. By shifting the sector on the

shaft it is possible without variation in the rate of rotation to make observations at the very beginnings of phosphorescence and to compare by simultaneous vision, the appearances, just before and immediately after the close of excitation, or on the other hand the earlier with the later stages, up to about .004 second. The photometer, spectroscope, spectrophotometer, camera, etc., may all readily be used with this form of phosphoroscope and studies of the most varied character become possible.

The instrument has already been employed in various determinations, some of the results of which have been reported elsewhere.

To study the change of color during the decay of phosphorescence in the case of certain sulphides, color photographs[15] by the Lumière process were taken, first of the glowing surface as it appeared through the sectored disk at full speed and then for comparison with the disk revolving very slowly.

To determine the effect of temperature the tube containing the sulphide was mounted within a cylindrical dewar bulb, and the lower end cooled to the temperature of liquid air. By keeping the upper end of the tube at + 20° C. a sharp temperature gradient along the axis of the tube was maintained and the very striking changes of color when the substance, under these circumstances, was excited to phosphorescence were photographically recorded.

Spectroscopic comparisons of the spectrum of the light emitted by the uranyl salts during fluorescence and at various stages during phosphorescence have been made with this phosphoroscope[16] and it has been found especially well adapted to the determination of the decay of phosphorescence in cases where, as in that of the uranyl salts, the entire process occupies only a few thousandths of a second.

EDWARD L. NICHOLS,
H. L. HOWES
PHYSICAL LABORATORY OF
CORNELL UNIVERSITY,
May, 1916

[15] Paper read at the April meeting of the American Philosophical Society, 1916.

[16] Nichols, *Proc. Nat. Acad. of Sciences*, 1916.

SCIENTIFIC QUEEN REARING

HAVING been engaged for several years in practical breeding of thoroughbred queens for commercial use, and realizing the certainty and definiteness of results if "Mendel's laws of heredity could be applied to bee breeding, I undertook to determine, if possible, the manner in which some of the most valuable traits of the different races of bees were transmitted through heredity, with the idea of combining in one strain of bees those qualities of recognized desirability, such as hardiness, prolificness, longevity, length of tongue and wing expanse. Color also was brought under observation as a means by which segregation could be more readily seen if it occurred in the second filial generation, as observed by Mendel in coat color of peas when a green-seeded variety was crossed on a yellow-seeded sort, in his experiments with the garden pea.

I was therefore much interested to see that Professor Newell, of College Station, Texas, was working along the same lines.[1] The conclusions at which he arrives, in some instances, do not accord with the facts brought out in a series of breeding tests that were conducted to determine certain (the same) characteristics.

Dzierzon was the first, I believe, to point out that drones were of the same zygotic constitution as the mother alone, and were produced parthenogenetically, the correctness of which is supported by some very convincing evidence, obtained by other reliable experimenters in the same field. Professor Newell says:

> Pure Italian queens mated to Carniolan drones produce only Italian drones, and Carniolan queens mated to Italian drones produce only Carniolan drones. This is strictly in accordance with the theory of Dzierzon, the daughters of Italian queens which have mated to Carniolan drones produce both Italian and Carniolan drones, produce them in equal numbers, and do not produce any other kind. (?) This is in accordance with the theoretical expectation under Mendelian law. (?)

[1] See "Inheritance in the Honey Bee," SCIENCE, N. S., No. 1049, pages 218–219, February 5, 1915.

If the constitution of a pure Italian queen be represented by II and of a pure Carniolan queen by CC, the former will produce gametes I and I, and the latter, gametes C and C, these being Italian and Carniolan drones respectively. (†)

These conclusions of Professor Newell are not verified in so far as I have been able to judge from the results obtained by breeding tests that I have made in various ways with drones reared from heterozygous queens. The Gulf Coast prairies near Houston, Texas, are ideal for the complete isolation of mating stations. With little difficulty locations can be found where there are no trees or shrubs of sufficient size to harbor a swarm, within a radius of from five to seven miles, which allow matings to be made with a reasonable degree of certainty.

To determine the behavior of the color factor in transmission, a pure strain of golden Italians and gray Caucasians (bred from queens that I imported) were chosen with which to make the primary or initial cross, the former giving workers of the brightest yellow color, while the workers of the latter are distinctly gray without a trace of yellow on the abdominal segments.

The result of mating a golden queen to a Caucasian drone is shown by the following scheme.

Golden queen — FFIIcc — gametes FIc, FIc × ffCCii — gametes fCi, fCi — Caucasian drone

Zygotes

FfIiCc FfIiCc FfIiCc FfIiCc = F_1

all heterozygous females, colored like ordinary Italian workers, showing that yellow is dominant to gray, a result agreeing entirely with Professor Newell's observations of the F_1 Italian-Carniolan Cross. The gray (dark) or recessive color does not appear in this generation of workers, the reciprocal cross gives the same results.

When queens are reared from these F_1 larvæ they produce drones of the constitution IiCc the same as the mother, a fact verified by subsequent breeding tests. The following scheme shows the result of mating a heterozygous queen to a heterozygous drone.

heterozygous queen — FFIiCc — ffIiCc — heterozygous drone

Zygotes

gametes FiC, FIc = fIc, fiC

FfIIcc FfIiCc FfIiCc FfiiCC = F_2

females, as will be observed, segregation occurs in this generation in a true 1:2:1 Mendelian ratio, or one pure dominant, two heterozygous dominants and one pure recessive, a result similar to that observed by Mendel in the F_2 of his cross of a tall pea on a short or dwarf variety, in which he got one TT, two Tt, Tt and one tt, or (dwarf) recessive; so it is in the case of the F_2 workers, in appearance there are three that show the dominant or yellow color of the Italians and one in four is recessive, or gray in color. This feature is markedly noticeable when queens are reared from larvæ of this generation; of the number hatched, about 25 per cent. show the pure golden color, 50 per cent. appear as ordinary Italian queens, with about the same variation in general color (that these are heterozygous in constitution is proved when bred to recessive drones) and 25 per cent. of them show only the recessive color, and in subsequent breeding prove to be pure recessives and continue to breed true when mated to recessive drones. The differences in the color of the workers of this F_2 are not so accentuated as in the queen reared from the same larvæ. As shown the pure dominant queens are golden, the impure dominants intermediate in color, while the recessives are gray without any trace of yellow on the abdominal segments.

Since drones are produced parthenogenetically, we must consider the fact that the egg of the queen at maturation, when not fertilized, is reduced from the 2N (or NN) condition to the 2N — 1 (or 2N — 2) condition, showing that a whole set, N, of chromosomes is not eliminated in maturation, but only one or two chromosomes. Hence the male condition here is 2N — 1 or — 2. The condition of the gametes formed, however, is N in both sexes. Since in fertilization only 2N zygotes are produced, they are (in the case of bees) invariably females.

Therefore in parthenogenetic reproduction it seems that the chromosomes FF, or factors for femaleness, are eliminated at parturition, and the resulting zygote is a male. And so far, as observed by the tests of breeding (regardless of color) the F_1 females (queens) produce drones of the constitution ffIiCc, and are heterozygous for the factors I and C with the allelomorphs i and c, whether in queen or drone, and the only gametes that can be formed from these are IC Ic iC ic, when such individuals are bred together, heterozygous workers, as well as both *pure* dominants and *pure* recessives are produced, making it possible to recover the pure line of either race used in making the initial or primary cross.

CHARLES W. QUINN
HOUSTON HEIGHTS, TEXAS

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 555th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, April 22, 1916, and called to order by President Hay at 8 P.M., with 24 persons present.

On recommendation of the council George H. Clements, Washington, D. C., was elected to membership.

On recommendation of the council the following resolutions were read:

WHEREAS: Professor Wells W. Cooke, distinguished ornithologist, authority on bird migration, treasurer of the Biological Society of Washington, and an active member of the council of the society, has passed from this life, therefore be it

Resolved: That the Biological Society of Washington deeply regrets the death of one for many years so keenly interested in the affairs of the society, one who was a peculiarly efficient officer, a wise counselor and a charming companion, and extends its warmest sympathy to the family of Professor Cooke.

Signed N. HOLLISTER,
J. W. GIDLEY,
ALEX. WETMORE

Under the heading Brief Notes, Dr. Howard E. Ames commented upon a question raised at the 553d meeting as to the existence of a South American mammal having the mammæ on the dorsal surface of the body. He had ascertained that this condition existed in the coypu (*Myocastor coypu*). Dr. Ames also offered information in regard to another question propounded at the same meeting as to the ability of camels to swim: According to Dr. E. A. Mearns dromedaries used in Abyssinia were able to swim; and in a book by an English army officer of experience Dr. Ames had found a statement to the effect that camels were powerful swimmers. Comments followed by the chair and by Dr. L. O. Howard.

Under the same heading Dr. F. H. Blodgett, plant pathologist at the A. and M. College of Texas discussed the embryology of the duck weed, *Lemna* and exhibited seeds, remarking that though the plant was common the seeds were found seldom. Dr. Caldwell, of Chicago, had worked out the development of *Lemna* to the point of fertilization. Studies made by Dr. Blodgett carried the embryology from this point. The talk was illustrated by diagrams. Discussion followed by Mr. W. L. McAtee.

The first paper of the regular program was by T. H. Kearney: "Native Plants as Indicators of the Agricultural Value of Land." Mr. Kearney outlined the results of field work carried on with Dr. Shantz in the semiarid regions of the United States west of the 98th meridian of longitude. Typical areas were surveyed in Colorado, the Great Basin and in the southwest desert region. Detailed surveys defined the dominant types of vegetation and their distribution, and these were correlated with the varying degrees of salinity, moisture content and other physical properties of the soil. Areas actually under cultivation gave a check as regards productivity. From these studies it is now possible to predict agricultural possibilities by examination of the original types of vegetation in these regions. Typical plant growths and diagrams showing distribution were illustrated by lantern slides.

Mr. Kearney's paper was discussed by Messrs. W. L. McAtee, Wm. Palmer, A. Wetmore and Dr. L. O. Howard.

The last paper of the regular program was by Dr. R. W. Shufeldt: "Comparative Study of Certain Cranial Sutures in the Primates." Dr. Shufeldt stated that no other single vertebrate structure had so much written about it or was receiving more attention at the present time than the skull in man and the primates in general. This study was begun over two thousand years ago and certain names of bones bestowed by Galen in the second century are still retained. In a series of 6,000 human and about 1,000 ape skulls in the collections of the U. S. National Museum Dr. Shufeldt found that while the bones of the face exhibited but little variation, in the bones on the lateral aspect of the cranium were remarkable variations,

many of which are not referred to in modern works on anatomy. Frontal, parietal, temporal, alisphenoid and malar articulations show many variations in sutural lines. These again are varied by the presence or absence of epactal or epipteric bones. By means of lantern slides and diagrams these were illustrated and compared and the speaker touched upon their value in taxonomy and racial distinction and their pathological significance. Discussion followed by Drs. L. O. Howard and H. E. Ames and Mr. Wm. Palmer.

Alexander Wetmore,
Recording Secretary, pro tem.

The 556th regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, May 6, 1916, called to order by President Hay at 8 P.M., with 45 persons present.

On recommendation of the council Victor J. Evans, Washington, D. C., was elected to active membership.

The president announced the recent deaths of Charles A. Davis and S. M. Gronberger, members of the society.

The first communication of the regular program was by M. W. Lyon, Jr., "Longevity of Bacteria." Dr. Lyon described a culture of *Bacillus paratyphosus B* which had been hermetically sealed in a glass tube in ordinary culture medium for the past ten years and exhibited a living subculture which had been made from it. He called attention to the short life of certain organisms and the long life of others, especially those producing spores. This communication was discussed by Dr. L. O. Howard and Mrs. E. M. Enlows.

The second paper of the regular program was by Dr. L. Stejneger: "The Amphisbænoid Lizards and their Geographic Distribution." Dr. Stejneger called attention to the various theories that have been advanced to account for distribution of animals and explained how the Amphisbænoid lizards with their peculiar morphology and habits were particularly adapted to show former connections with now separated land masses and islands. The distribution and relationships of these lizards clearly showed a former land connection between South America and Africa. Dr. Stejneger's paper was illustrated by charts, diagrams and maps, showing the classification, the structural taxonomic characters, probable evolution and geographic distribution of the Amphisbænoid lizards. The chair, Drs. L. O. Howard, C. H. T. Thownsend, General Wilcox and others took part in the discussion.

The last paper of the evening was by W. L. McAtee: "Sketch of the Natural History of the District of Columbia." Mr. McAtee gave a very interesting historical account of the study of the natural history of the District of Columbia from the earliest accounts of Capt. John Smith who ascended the Potomac River as far as Little Falls and made notes on the fauna of the region; and the account of other early explorers and travelers, down to recent times. The speaker gave many entertaining quotations from the writings of these early naturalists, told about the early societies interested in the natural history of the District, and described the faunal and floral lists that have appeared, mentioning the number of species in each, and calling attention to the fact that the District of Columbia is the type locality for many species. Mr. McAtee's communication was discussed by the chair, Dr. L. O. Howard, D. E. Lantz and Wm. Palmer.

M. W. Lyon, Jr.,
Recording Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 488th meeting of the society, held October 13, 1915, jointly with the Medical Society of the District of Columbia, Dr. Aleš Hrdlička read a paper on "The Evolution of Man in the Light of Recent Discoveries and its Relation to Medicine." Human evolution is now an accepted doctrine in natural history. In addition to the older evidence in the analogies between man and other mammals, the resemblances in embryonic development, the presence of vestiges or reversions, and the like, in recent years a large series of prehistoric remains have completed the demonstration. The evidence is conclusive, although there are as yet important gaps in the line, especially relating to the earlier periods. Among recent changes in man's "evolution" are deterioration of the teeth and disharmonies in the facial structure. Parts which become less useful are eliminated or weakened and degenerated. Progressive and retrogressive changes that are not harmonious or beneficial necessitate medical or surgical intervention. The erect posture results in greater disorders, as in pregnancy. The great enlargement of the brain results in imperfections. The ability of procreation is adversely affected. The study needs the enlightened help of all branches of medicine.

Daniel Folkmar,
Secretary

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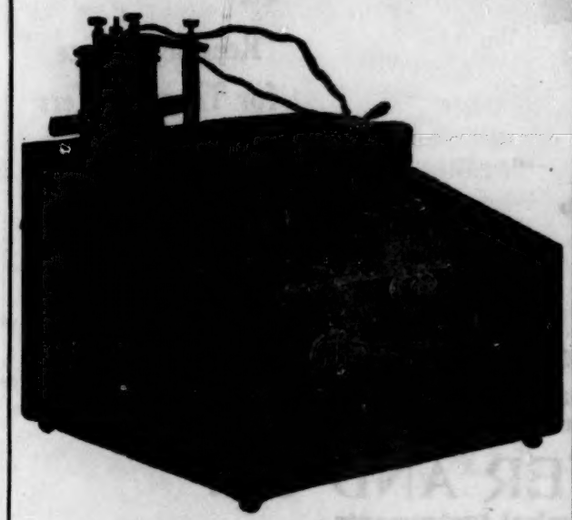

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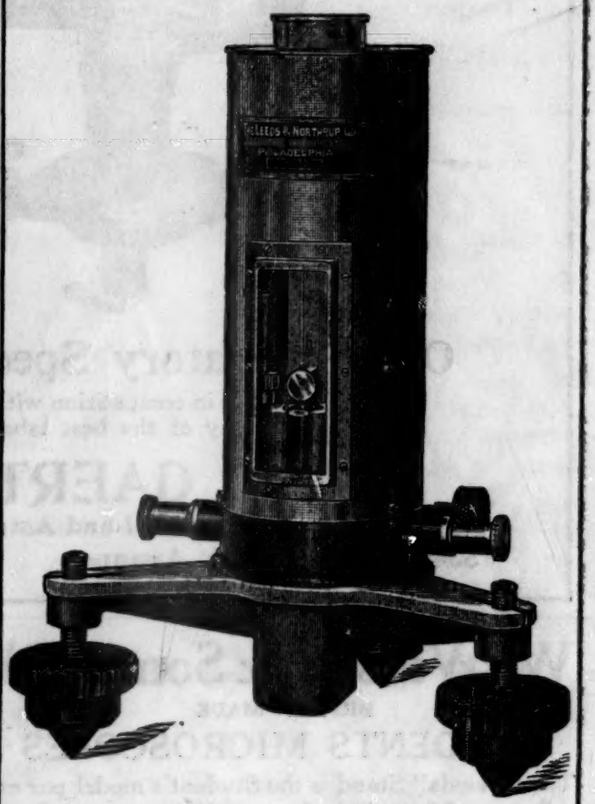

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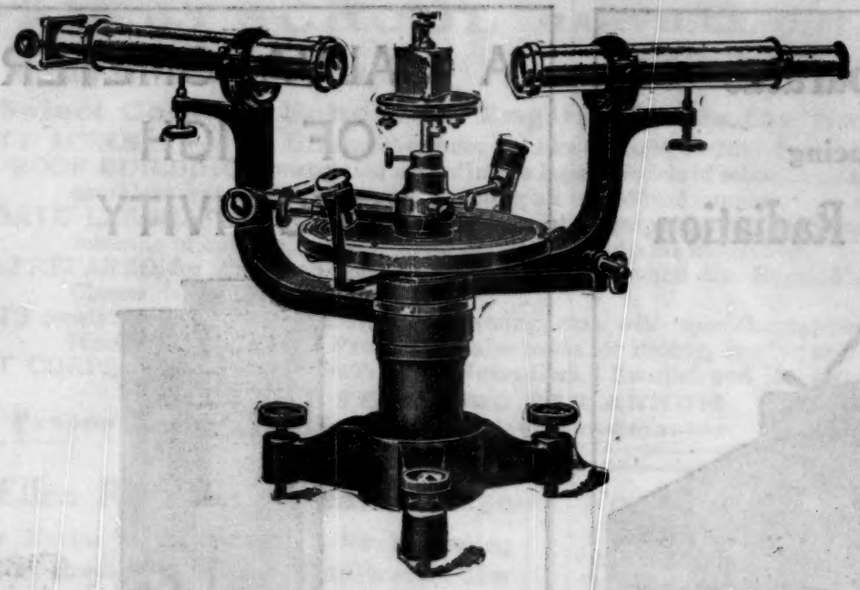

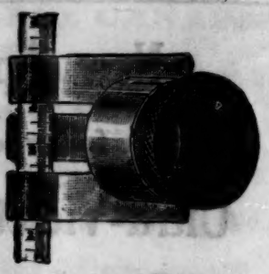

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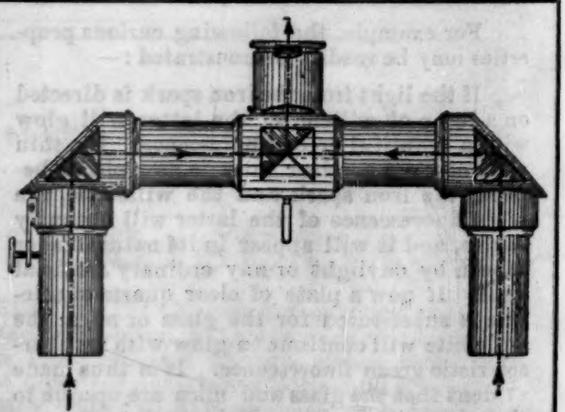

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